A GUIDE TO THE GEOLOGY OF THE SHAWNEETOWN AREA Gallatin County

Geological Science Field Trip

David L. Reinertsen

Field Trip Leaflet 1988A April 16, 1988
Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
Champaign, IL 61820

A GUIDE TO THE GEOLOGY OF THE SHAWNEETOWN AREA

David L. Reinertsen

GEOLOGICAL SCIENCE FIELD TRIPS are free tours conducted by the Educational Extension Section of the Illinois State Geological Survey to acquaint the public with the geology, landscape, and mineral resources of Illinois. Each is an all-day excursion through one or several counties in Illinois; frequent stops are made for explorations, explanations, and collection of rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers in preparing earth science units. Grade school students are welcome, but each must be accompanied by a parent. High school science classes should be supervised by at least one adult for each ten students. A list of previous field trip guide leaflets is available for planning class tours and private outings.

THE GEOLOGIC FRAMEWORK

The Shawneetown area straddles the boundary between the Mt. Vernon Hill Country of the Till Plains Section of the Central Lowland Province and the northeastern edge of the Shawnee Hills Section (also known as the "Illinois Ozarks") of the Interior Low Plateaus Province (fig. 1). The rugged, scenic landforms of the Shawnee Hills, extending across extreme southern Illinois, present a great topographic contrast to the flat, alluviated plain of Saline River. The sharp hills mark the northern and western rim of the Eagle Valley Syncline. The highest parts of the hills in this field trip area are at mean sea level (m.s.l.) elevations greater than 700 feet, while the lowlands are about 350 feet. The surface relief of the area, therefore, is about 350 feet.

The field trip area lies on the southern flank of the Illinois Basin, a broad, oval bedrock depression formed by gentle downwarping of sedimentary layers (strata) beneath much of Illinois and adjacent parts of Indiana and Kentucky (figs. 2 and 3). The Shawneetown area is about 45 miles south of the deepest part of the basin, which is located in Wayne County.

Bedrock in the field trip area consists of approximately 15,000 feet of Paleozoic sedimentary rocks ranging in age from late Cambrian (about 550 million years old) to middle Pennsylvanian (about 290 million years old) (fig. 4). The Cambrian rocks rest on an ancient surface of Precambrian igneous and metamorphic rocks more than 1 billion years old. This great thickness of sedimentary strata, consisting of sandstone, shale, limestone, and coal, was deposited layer upon layer in the ancient shallow seas that invaded the Illinois Basin and the midcontinent during the Paleozoic Era.

Approximately 1,100 feet of Paleozoic rocks are exposed in the field trip area (fig. 5). These rocks range in age from early to middle Pennsylvanian (about 315- to 290-million years old) (fig. 6). The area is an excellent place to study the lower half of the Pennsylvanian System, as an almost complete section of these rocks is exposed here. Pennsylvanian strata contain several important coals which have been mined for many years. Other mineral resources include sand and gravel and limestone.

The bedrock structure in the Shawneetown area is very complex. Three major sets of faults are present in the area--the Rough Creek-Shawneetown, the Wabash Valley and the Fluorspar Area Systems (see attached Geologic Map of Illinois). The major fault here is the Shawneetown Fault Zone, which bisects the field trip area from east to west and consists of several nearly parallel high-angle reverse faults. The zone is 3,500 to 7,500 feet wide and shows vertical displacement ranging from 900 to more than 2,000 feet along the Front Fault, the northern most and largest of the faults. North of the fault, the Paleozic strata are tilted gently northward into the Illinois Basin. South of the fault, bedrock strata are downwarped gently into the Eagle Valley Syncline (fig. 7).

During Illinoian time (nearly 300,000 years ago) North American continental glaciers reached their southernmost limit of advance, about 40 miles to the southwest of the Shawneetown area. Shawneetown is about 11 miles southeast of the inferred glacial margin in this area. Here, however, extensive sediments of glacial Lake Saline and thick loess (pronounced "luss") deposits record the effects of the glaciations that took place just a few miles to the north and to the west.

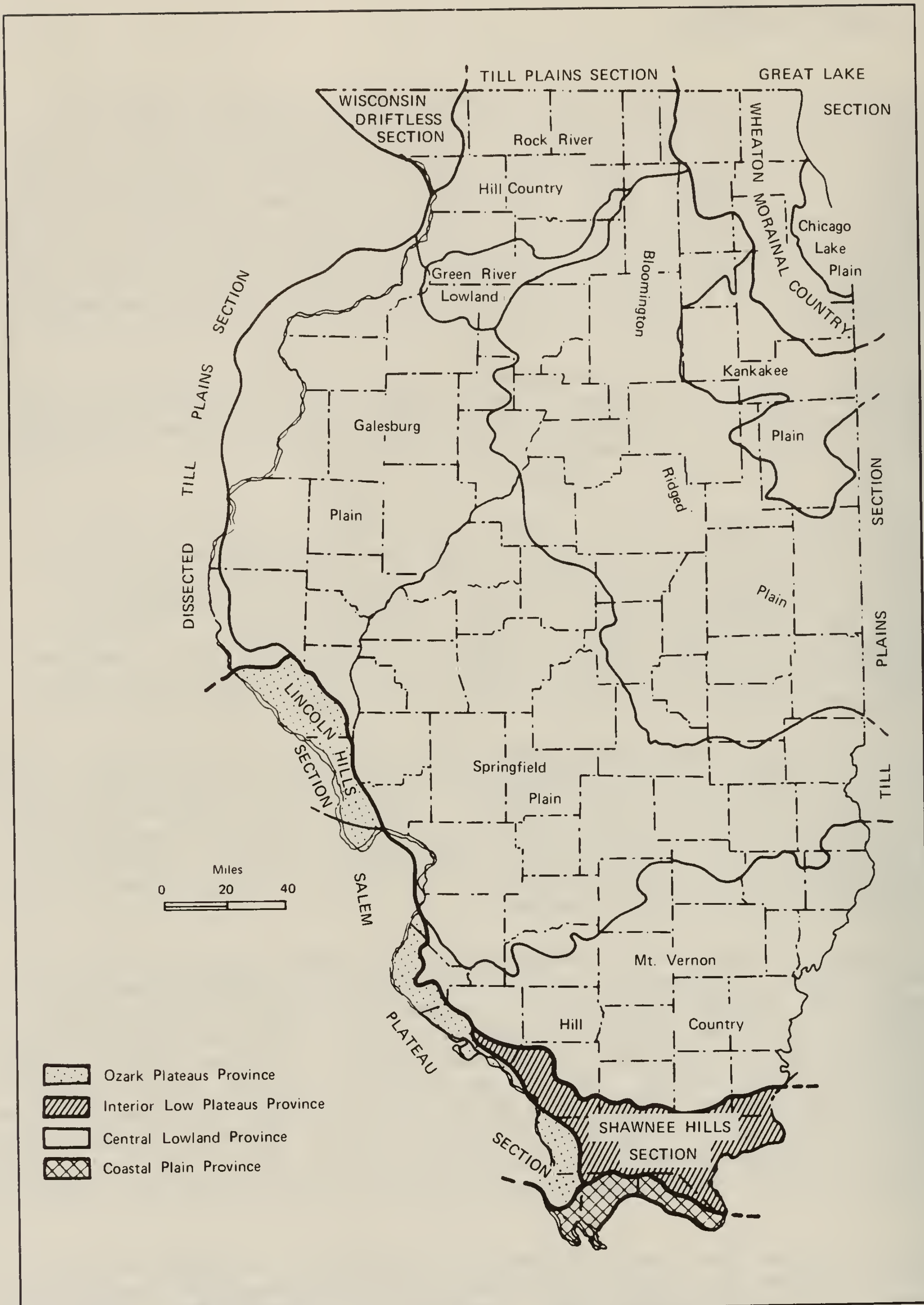


Figure 1 Physiographic divisions of Illinois

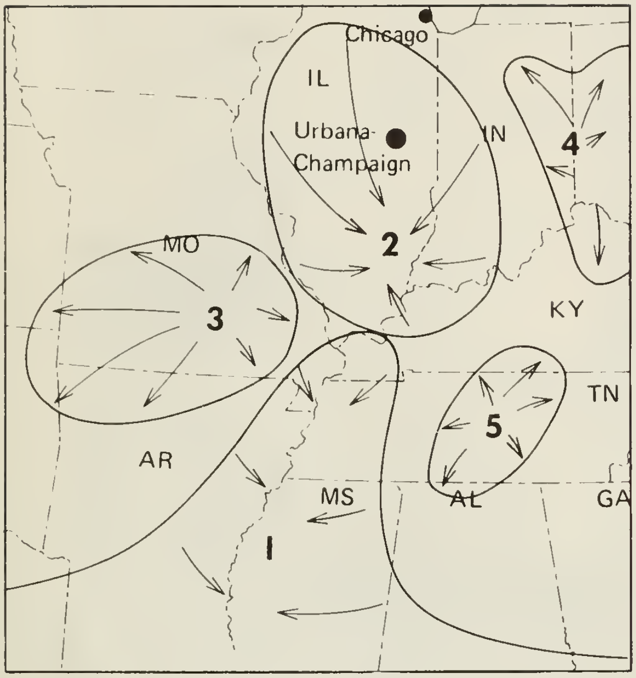


Figure 2 The location of the Mississippi Embayment and adjacent major structures: (1) Mississippi Embayment, (2) Illinois Basin, (3) Ozark Dome, (4) Cincinnati Arch, and (5) Nashville Dome.

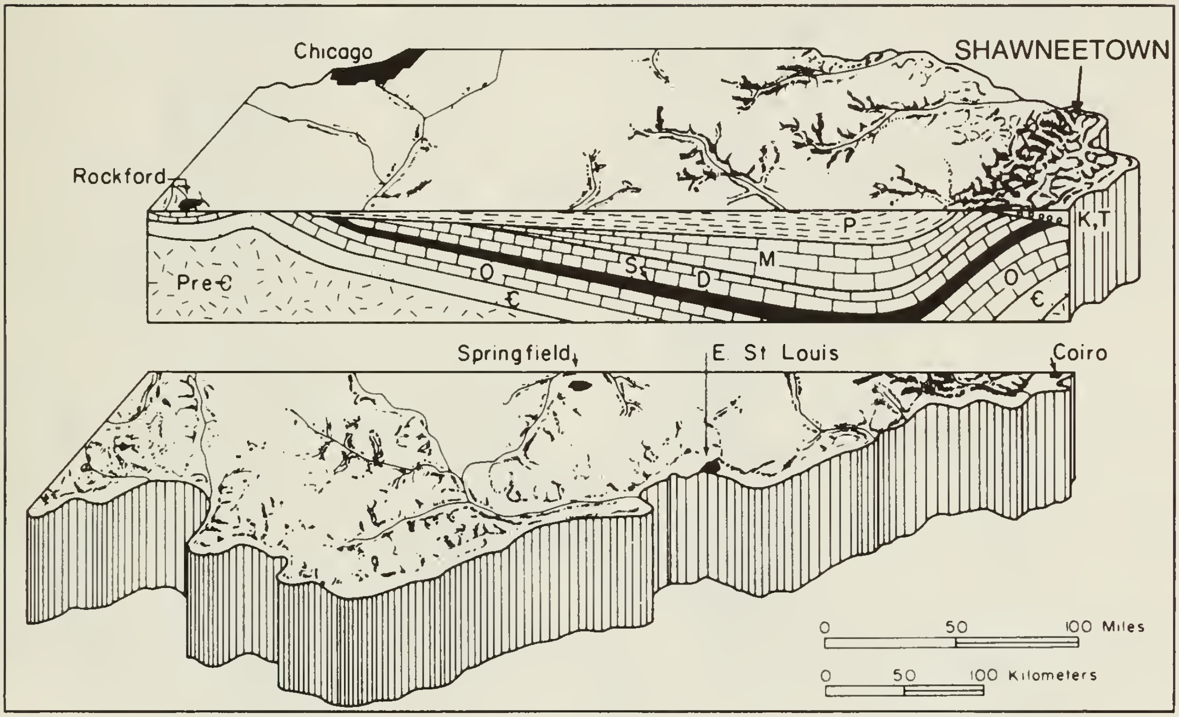


Figure 3 Stylized north-south cross section shows the structure of the Illinois Basin. In order to show detail, the thickness of the sedimentary rocks has been greatly exaggerated and the younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Pre-cambrian (Pre-C) granites. They form a depression that is filled with layers of sedimentary rocks of various ages: Cambrian (C), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). The scale is approximate.

ERA	SYSTEM	SERIES	GROUP	FORMATION	GRAPHIC COLUMN	THK. (ft)
CENO-ZOIC	QUATERNARY	PLEISTOCENE		loess, alluvial and lacustrine deposits,		0 - 150
	TERT. - QUAT.	PLIO. - PLEISTO.		Mounds Gravel		0 - 20
PALEOZOIC	PENNSYL-VANIAN	MISSOURIAN	McLeansboro	Bond		0 - 125
				Modesto		375 - 475
		DESMOINESIAN	Kewanee	Carbondale		350 - 400
				Spoon		350 - 400
		ATOKAN	McCormick	Abbott		300 - 400
		MORROWAN		Caseyville		250 - 450
	MISSISSIPPIAN	CHESTERIAN		Many (see fig. 6)		900 - 1200
		VALMEYERAN		Ste. Genevieve-others		150 - 200
				St. Louis Ls.		400 ±
				Salem Ls.		400 ±
				Ullin Ls.		300 ±
				Ft. Payne		200 ±
	DEVONIAN	UPPER	New Albany	undifferentiated		200 - 400
		MIDDLE		Lingle Ls.		0 - 100
				Grand Tower Ls.		100 - 350
		LOWER		Clear Creek Chert		250 - 450
				Backbone Ls.		30 - 50
				Grassy Knob Chert		200 - 550
				Bailey Ls.		200 - 450
	SILURIAN	NIAGARAN				
		ALEXANDRIAN		three formations		150 - 350
	ORDOVICIAN	CINCINNATIAN	Maquoketa	undifferentiated		200 - 425
		CHAMPLAINIAN	Galena	undifferentiated		15 - 130
			Platteville	undifferentiated		500 - 600
			Ancell	Joachim		250 - 950
				Dutchtown		
				St. Peter		50 - 200
			Knox Megagroup	Everton Dolomite		50 - 600?
		CANADIAN		undifferentiated		1800 - 3600
	CAMBRIAN	CROIXAN		Eminence Dolomite		350 - 900
				Potosi Dolomite		800 - 1000
				Franconia Ss.		900 - 1350
				Eau Claire Dolomite		800 - 2700
			Potsdam Sandstone Megagroup	Mt. Simon Ss.		0 - 700?
		MIDDLE AND LOWER?		pre - Mt. Simon (Mermet Ss., Rome, Conasauga?)		564 +
PRECAM-BRIAN						

ISGS 1984

Figure 4 Generalized stratigraphic column for the Shawneetown area (from Nelson and Lumm, 1987).

Figure 5 Generalized geologic map of the Shawneetown field trip area (adapted from Nelson and Lumm, 1987).

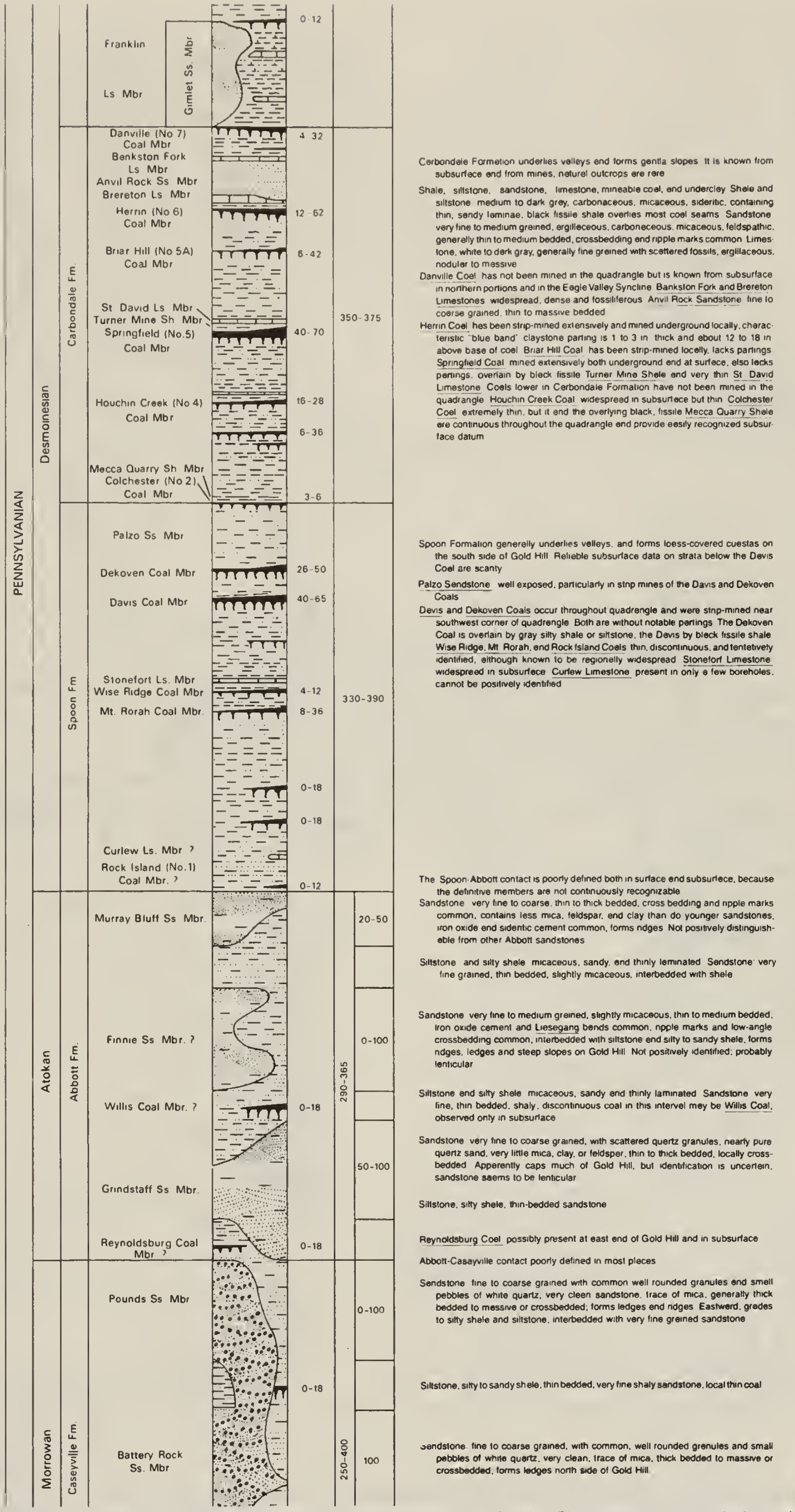


Figure 6 Generalized Pennsylvanian stratigraphic column for the Shawneetown area (adapted from Nelson and Lumm, 1986).

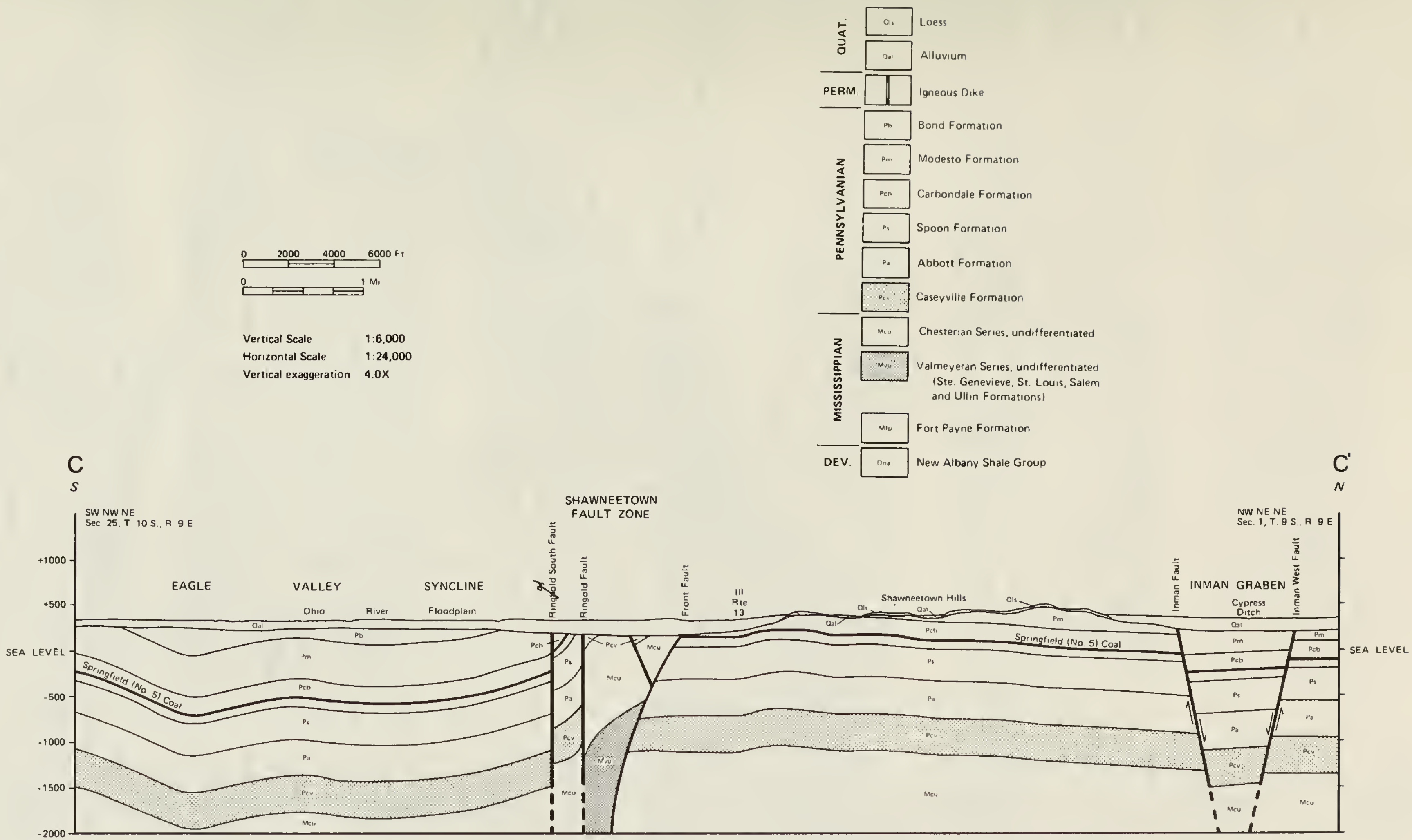


Figure 7 North-south cross section located just east of Gold Hill, Shawneetown Quadrangle (from Nelson and Lumm, 1987).

Mineral Production

Ninety-eight of the 102 counties in Illinois reported mineral production during 1985, the last year for which totals were available. The total value of all minerals extracted, processed, and manufactured in Illinois was more than $3.7 billion. In 1985, minerals extracted in order of value in Gallatin County were coal, crude oil, sand and gravel, and natural gas with a total value of more than $61.5 million. The county ranked 19th among the Illinois mineral producing counties.

Four mines (2 drift, 1 slope, and 1 strip) operating in three different coal seams in Gallatin County produced more than 1.5 million tons of coal valued at more than $48 million. Total tonnage of coal produced in 21 Illinois counties was more than 60.47 million tons valued at more than $1.86 billion.

Approximately 498,000 barrels of crude oil valued at more than $13.4 million were produced in Gallatin County during 1985. Crude oil produced in 47 Illinois counties was slightly more than 30.2 million barrels, with a value of more than $813 million.

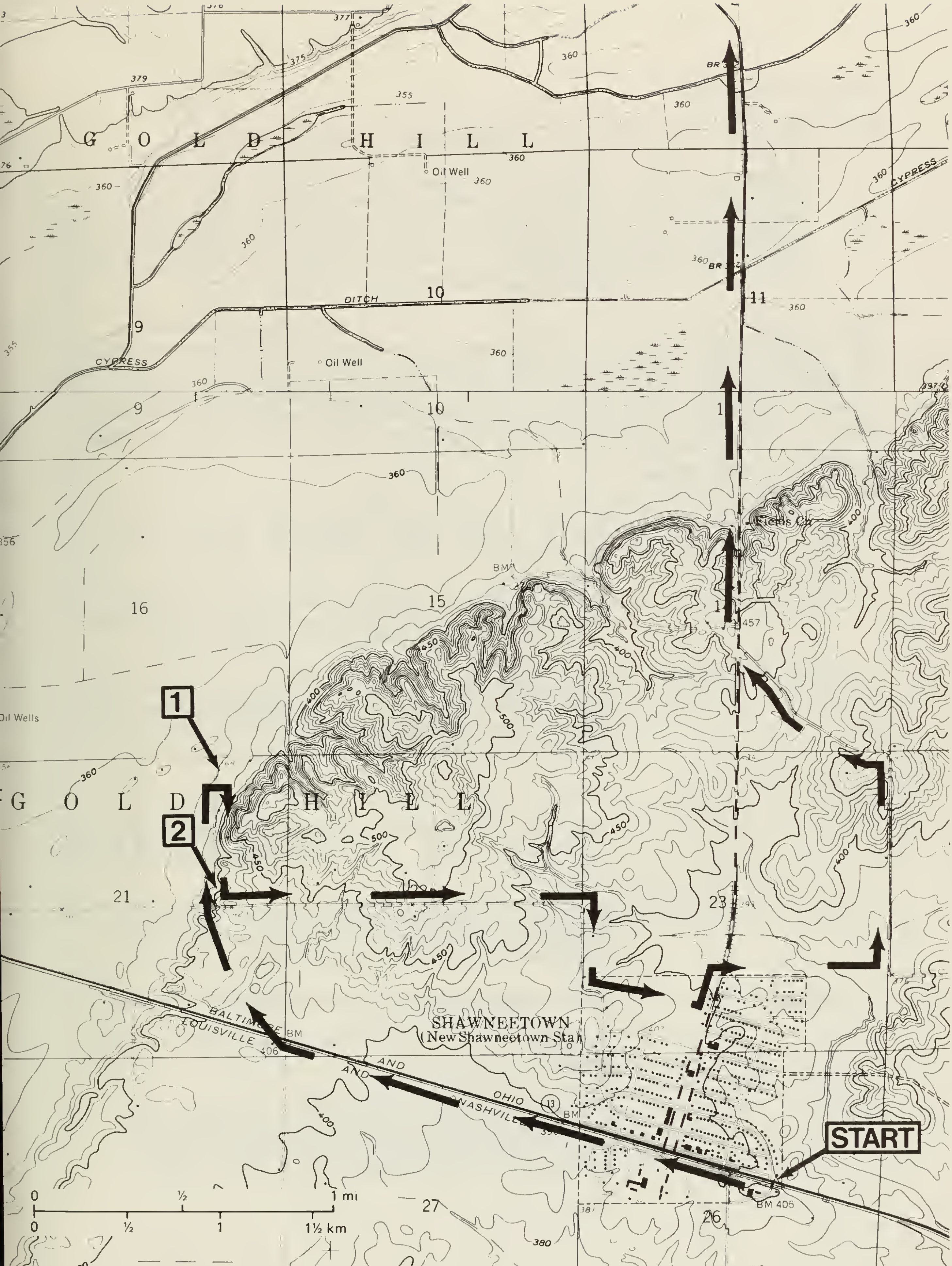
Sand and gravel production was reported in Gallatin County during 1985. Because the U.S. Bureau of Mines only surveys sand and gravel operators in even-numbered years, only estimates for the industry as a whole can be presented here. Nearly 26.6 million tons of sand and gravel having a value of more than $77 million were produced in Illinois that year.

Groundwater is a mineral resource that is frequently overlooked in assessments of an area's mineral potential. Groundwater occurs in underground reservoirs present in beds of glacial sand and gravel, stream alluvium, or porous or creviced bedrock strata.

Several communities in western Gallatin County and farther west in Saline County experience periodic water shortages. These communities obtain their water from various sources, none of which is adequate to supply the increasing water demands of the area. The Saline Valley Conservancy District asked the State of Illinois for assistance in exploring for and developing groundwater resources in their area.

Regional aquifer systems in Illinois are being assessed as part of an ongoing program by the Water Resources Division of the Illinois Department of Transportation and the State Geological Survey and State Water Survey Divisions of the Illinois Department of Energy and Natural Resources. A comprehensive hydrologic study ensued which included the reevaluation of existing subsurface and geophysical data augmented by extensive surface electrical resistivity surveys and a controlled drilling, sampling, and testing program. Analyses of formation samples recovered during test drilling were used in conjunction with the geophysical logs to determine the character and distribution of potential aquifers in this study region.

A high-capacity test well and three observation wells were constructed, and a controlled aquifer test was conducted to evaluate the production capabilities of a promising sand and gravel aquifer. Analysis of the study data shows that a 3 million gallons per day well field can be successfully completed at a location 1.5 miles north of the community of Junction and 1.25 miles northwest of field trip Stop 1. Subsequently wells were completed there and a water treatment plant was constructed east of Cypress Ditch along SR 13.


GOLD HILL
Oil Well
DITCH
CYPRESS
SHAWNEETOWN
(New Shawneetown Sta)
BALTIMORE
LOUISVILLE
AND
OHIO
NASHVILLE
START
1
2
0
½
1 mi
1
1½ km
BM 405

GUIDE TO THE ROUTE

NOTE: The number in parentheses following the topographic map name, (37088F2), is the code assigned to that map as part of the National Mapping Program. The state is divided into 1^{0} blocks of latitude and longitude. The first pair of numbers refers to the latitude of the southeast corner of the block and the next three numbers designates the longitude. The blocks are divided into 64 7.5-minute quadrangles; the letter refers to the east-west row from the bottom and the last digit refers to the north-south row from the right.

Head northerly on the drive along the east side of the Shawneetown Junior-Senior High School. CAUTION: cross rough abandoned railroad crossing between the parking lot and State Route (SR) 13 where mileage figures begin. Note to the right (east) from the abandoned crossing is a lush stand of Equisetum, an ancient plant type that is regarded as the oldest living vascular plant with ancestors traceable to the Pennsylvanian Period nearly 300 million years ago.

Miles to Next Stop	Miles from Start	
0.0	0.0	CAUTION: STOP; 1-way. TURN LEFT (westerly) on SR 13.
0.35	0.35	To the right at the end of the boulevard is the Gallatin County Courthouse, which is constructed of southern Illinois sandstone from Pope County.
0.45	0.8	To the left is Gold Hill the northern limb of the Eagle Valley Syncline. It is bounded on the north side by the Front Fault of the Rough Creek-Shawneetown Fault Zone.
0.7	1.5	Prepare to turn right.
0.2	1.7	TURN RIGHT (northerly and then west) at the Peabody Eagle #2 Mine sign. The oil and chip road is a little rough.
0.15	1.85	This area of very pronounced rolling topography, is composed of sand dunes. The thin cover has been broken so the wind is able to erode the dunes.
0.35+	2.2+	STOP: 2-way crossroad. CONTINUE AHEAD (north).
0.3	2.5+	CAUTION: enter Peabody Coal Company Eagle #2 Mine property.
0.1+	2.65-	CAUTION: TURN RIGHT just beyond the yield sign. Pull into a parking area that is outside of the fenced tipple and mine office complex. Follow directions in parking and do NOT block gates.
0.05-	2.65	**STOP 1.**

STOP 1. Peabody Coal Company Eagle No. 2 Mine [NW 1/4 NE 1/4 NE 1/4 Sec. 21, T. 9 S., R. 9 E., 3rd P.M., Gallatin County; Shawneetown 7.5-minute Quadrangle (37088F2)].

The Eagle No. 2 Mine began producing coal from the Springfield Coal Member of the Pennsylvanian Carbondale Formation early in 1969. The Springfield Coal averages slightly more than 5 feet thick and lies approximately 225 feet deep at this locality. The depth to the coal increases to the north because of the northward dip of the bedrock. The interval from the surface down to the top of bedrock here is about 70 feet and is largely composed of unconsolidated sandy lake sediments.

This mine is called an underground slope mine because the 16-foot diameter haulageway, along which men and materials enter and leave the working area, is inclined at an angle of 16.5 degrees from the horizontal. Operating on a three shift per day basis, Eagle No. 2 Mine was designed to produce 13,000 to 14,000 tons of coal per day and employ 325 to 350 men. The area to be mined out will be 5 miles wide from east to west by 7 miles long from north to south. Conventional mining machines to undercut and load the coal were used until the mid- to late '70s when continuous mining machines were used. The work force at this mine was reduced to about 340 during late 1987, and operations went to two producing shifts and one shift for maintenance and repair. The mine produces about 7600 tons of raw coal per day which yields approximately 4600 tons of clean coal. Production in 1986 amounted to more than 975,000 tons which pushed the total for the mine to more than 12.6 million tons since it commenced mining operations.

Coal is brought via conveyor belt to the surface where it passes through a series of shakers, breakers, and screens before being stockpiled. A company-owned railroad transports the clean coal about 5 miles to its loading dock on the Ohio River at Old Shawneetown. There the coal is loaded for barge shipment to electric power utilities.

Miles to Next Stop	**Miles from Start**	
0.0	2.65	Leave Stop 1 and retrace route to the south. Use EXTREME CAUTION leaving the area.
0.05-	2.65+	CAUTION: TURN LEFT (south).
0.1	2.75+	Note pronounced gullying to the left. CONTINUE AHEAD (south).
0.05+	2.85	The large partially denuded exposure to the left resulted originally from construction of the mine road. The road is cut through a portion of the west end of the sand dunes. Subsequent grazing has caused slumping of these unstable earth materials. Do NOT cross the fence

Miles to Next Stop	Miles from Start	
0.1	2.95	Note that trash has been thrown into some of the small gullies on the left to try to retard erosion.
0.1	3.05	Park on right shoulder as far off the road as you can safely. Do NOT block view of the stop sign just ahead. Stop #2 is just around the corner to the left but road is too narrow for parking there.

STOP 2. Roadcut in dune sand on north side of east-west road [SW 1/4 SE 1/4 NE 1/4, Sec. 21, T. 9 S., R. 9 E., 3rd P.M.; Shawneetown 7.5-minute Quadrangle (37088F2)].

About 25 feet of light brown, very fine grained calcareous sand are exposed in this roadcut. This sand forms part of a mile-wide belt of wind-blown sand that extends along the northwest side of Shawneetown Hills, southwestward, past the village of Junction, to the west end of Gold Hill. The west edge of this sand belt forms a narrow, fairly sharp ridge of low dunes that can be traced for 2 1/2 miles.

The sand in this exposure is evenly laminated. The laminations are tilted down to the northeast, indicating that the sand was deposited by winds blowing from the southwest. The sand is extremely well sorted (uniform particle size), a property that is typical of wind deposits. The sand also contains a terrestrial snail fauna, which includes the following species: Discus cronkhitei, Succinea grosvenori, Succinea gelida, and Pupilla muscorum. These snails are very small in size (fig. 8).

The sand was blown from the lake plain to the west of here after the Maumee flood waters receded and the lake was drained (fig. 9). After drying, the unconsolidated lake sediments were easily eroded by the wind.

The dune sand is overlain by several feet of oxidized, reddish brown loess, a compact deposit of clayey silt. The loess is also a wind deposit and represents the finest material transported by the wind. The loess at this locality can be seen best in the cut along the east-west road just east of the crossroads. The loess is draped over the top of the dune sand and is thickest on the east slope of the ridge, indicating that it was also deposited by prevailing westerly winds.

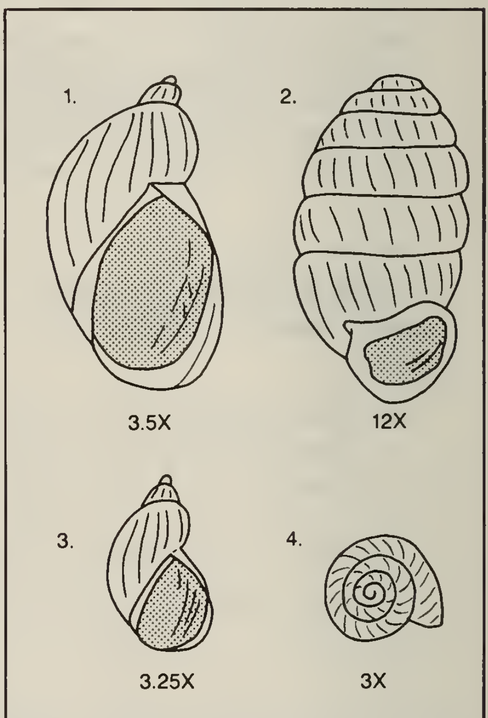


Figure 8 Terrestrial snails in the sand at Stop 2. Enlargements are indicated. 1. *Succinea grosvenori*; 2. *Pupilla muscorum*; 3. *Succinea gelida*; and 4. *Discus cronkhitei*.

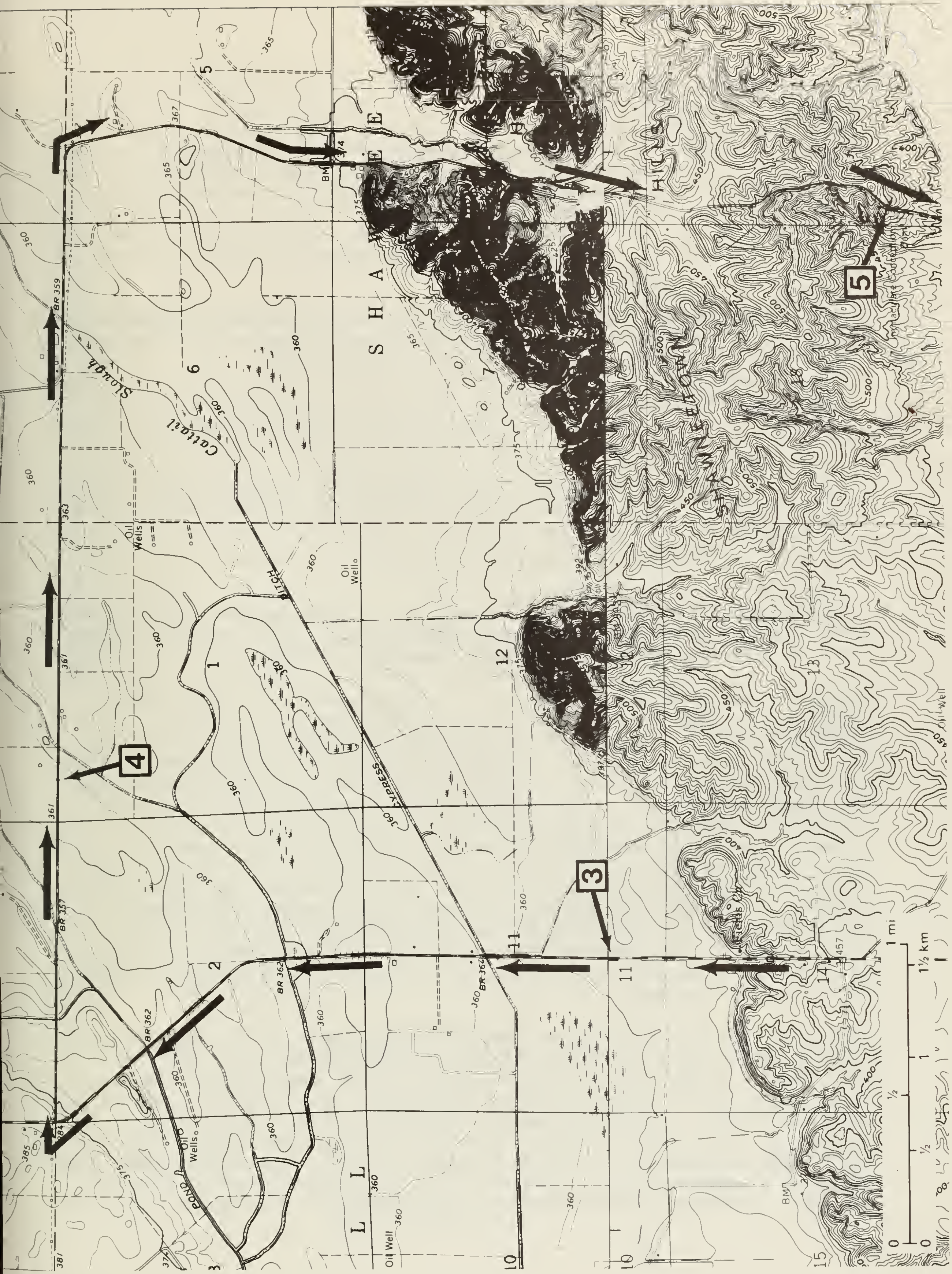
SYSTEM	SERIES	FORMATION AND MEMBER	LITHOLOGY	THICKNESS OF COAL SEAM IN INCHES	THICK-NESS IN FEET	DESCRIPTION
QUATERNARY	Pleistocene	Cahokia Alluvium and Equality Formation			0–150	Cahokia Alluvium: up to 150 ft. of clay, silt, sand, and gravel on modern flood plain of Ohio River and in abandoned channel between Gold Hill and Shawneetown Hills; clay, silt, sand, and rock debris in stream valleys and ravines; thin veneer of silt and clay overlying lacustrine deposits. Equality Formation: lacustrine mud, clay, silt, and firm sand, massive to well laminated, Illinoian and Wisconsinan.
		Parkland Sand			0–50	Parkland Sand: white to light gray, very fine to fine grained, well sorted, crossbedded; contains small gastropod shells; wind-blown sand; forms stabilized dunes on east side of Maumee Flood Channel; grades eastward to silt (loess)
		Loess			0–30+	Silt: slightly clayey, compact, rooted; contains calcareous tubules; stands in nearly vertical banks; buff-tan Peoria Loess (Wisconsinan) can be distinguished from an older red-brown Illinoian loess in some exposures
		Maumee Flood deposits			0–150	Clay, silt, and thick water-bearing sand and gravel, especially at base
PENNSYLVANIAN						

Figure 9 Quaternary deposits in the Shawneetown area (adapted from Nelson and Lumm, 1986).

Loess thinly blankets the uplands throughout the field trip area, and in some places it is as much as 20 feet thick. The loess was deposited principally during the latter part of the Wisconsinan glaciation, between about 22,000 and 10,000 years ago. Meltwater from the glacial front flowed down major valleys like the Mississippi, Illinois, and Ohio Valleys. These valleys became partially filled by out-wash (clay, silt, sand, and gravel) released from the melting glacier. Silt and clay were eroded from the floodplains of these valleys by the wind during the winters when the meltwaters receded and permitted the floodplain sediments to dry out. These materials were transported eastward from these valleys and deposited as loess over the uplands.

In this immediate area, the dune sand was being deposited at the same time that loess was being deposited elsewhere in the field trip area. Loess did not accumulate here until the dune became stabilized by vegetation. Therefore, the few feet of loess exposed here represents only the youngest part of the Wisconsinan loess.

Miles to Next Stop	Miles from Start	
0.0	3.05	Leave Stop 2. CONTINUE AHEAD (south) on mine road.
0.05-	3.1-	STOP: 2-way, crossroad. TURN LEFT (east) and ascend dune. Although oil and chip, the road ahead is rough.
0.1+	3.2+	To the left is a field entrance. The field has been plowed and prepared for planting. This very fine sandy soil has had the cover crop destroyed in this process. Any strong winds or heavy rains are going to gully the field or blow substantial amounts of the soil away.
0.35	3.55+	To the right, you see gullying that has started to occur in the wheat field after the wheat was planted last fall.
0.65-	4.2-	Notice the creek crossing here. There has been alot of refuse discarded in the creek and in the ditches to the east despite the no dumping signs that are posted.
0.25+	4.45	CAUTION: Enter northwest side of Shawneetown on Marshall Avenue.
0.1+	4.55+	TURN LEFT (east) on West Roosevelt Avenue.
0.25+	4.8+	CAUTION: yield sign at the intersection of McLean Road. CONTINUE AHEAD (easterly).
0.15+	5.0+	STOP: 4-way. TURN LEFT (northerly) on Lincoln Boulevard.
0.1+	5.1+	TURN RIGHT (east) on Galt Avenue.
0.3	5.4+	To the right is the City Park. CONTINUE AHEAD (east).
0.1+	5.55	Cross the bridge and prepare to turn left at T-road intersection.
0.1+	5.65+	TURN LEFT (north). The rounded hills in this vicinity are loess-covered Pennsylvanian strata of the Modesto Formation.
0.55+	6.25+	At the crest of this first little knob, look to the right to see some rather severe gullying that is developing in the wheat field. One or two heavy rains have done that much damage after the wheat was sown.


Cattail Slough
CYPRESS DITCH
SHAWNEETOWN HILLS
Oil Wells
Oil Well
3
4
5
0 1/2 1 mi
0 1/2 1 1 1/2 km

Miles to Next Stop	Miles from Start	
0.05	6.3+	To the left, land clearing is taking place. You can see the potential for more serious gullying and erosion of this hilltop if that area is put into crops.
0.1+	6.4+	TURN LEFT at the road corner; the other roads are driveways.
0.6	7.05+	STOP: 1-way; angle intersection with Shawneetown blacktop. CAUTION: Traffic moves fast. Stop sign is missing. BEAR RIGHT (north).
0.05-	7.1-	Note the loess exposed in the roadcut on the right. Since it has been cut on an angle, it will erode until a vertical face has been established.
1.2	8.3-	Pull off to the right as far as you can and stop. CAUTION: fast traffic, stay off of roadway.

STOP 3. Discussion of glaciation and its effects on the Shawneetown area [NW 1/4 SW 1/4 SW 1/4 NE 1/4, Sec. 11, T. 9 S., R. 9 E., 3rd P.M.; New Haven SW 7.5-minute Quadrangle (37088G2)].

Although, as noted in the introduction, glaciers apparently did not extend into this area, the Illinois glacier came within about 8 miles to the northwest of here. Prior to that time, nearly 300,000 years ago, the Saline River evidently flowed eastward along the north side of the Shawneetown Hills before joining the Ohio River a few miles to the east. The Saline River was much deeper then than it is now. The old valley was partially filled with outwash materials from the melting Illinoian glacier, but the river was unable to remove all of this debris at a later time. Still later, Wisconsinan glaciers extended southward into Illinois and Indiana but did not get closer to this area than 110 miles north of here. However, tremendous volumes of meltwater coursed down the Wabash River valley from the melting of both the Lake Michigan and Lake Erie glacier lobes, especially the latter. Fidlar (1948) estimated that the Wabash River must have been at least 5 miles wide and 15 to 20 feet deep throughout part of its course during the summers when melting was at a maximum.

During early Wisconsinan time, meltwater from glacier lobes in Lakes Erie and Michigan carried large quantities of outwash material down various drainageways. Deposition of these sediments farther downstream caused many of the tributary streams of the large drainageways to pond and form extensive slackwater lakes. A large slackwater lake, Lake Saline, covered parts of five counties in this region (see map of Quaternary Deposits of Illinois in PLEISTOCENE GLACIATIONS OF ILLINOIS appendix). These lakes fluctuated in size throughout Wisconsinan time. Studies of faint terraces along what must have been the Lake Saline shoreline suggest that the highest lake level, nearly 400

feet, was attained during early Woodfordian time (about 20,000 radiocarbon years B.P.). Although the lake held at this level for no more than 1,000 years, sediment-choked streams flowing into the lake deposited as much as 150 feet of sediment. The lake persisted for 3,-4,000 years. The high-level phase of Lake Saline ended during mid-Woodfordian time when the major streams incised channels through the thick outwash fills, removing the barriers that had produced the slackwater lakes. New drainage across the lake plain was established, including the lower part of Saline River that now passes through the narrow area between Gold Hill and Wildcat Hills.

Although subsequent outwash deposition caused lakes to form again, they never reached the high levels of early Woodfordian time. Glacial Lake Maumee, the precursor to modern Lake Erie, drained westward down the Wabash Valley about 14,000 years B.P. These flood waters eroded a surface called the Maumee Terrace as they passed on both the east and west sides of the Shawneetown Hills. This terrace exhibits a distinctive linear topography and erosional surface that are apparent in this vicinity.

The former lake bed in the Saline River Valley still floods with Ohio River backwater from time to time with the result that the Pleistocene lake sediments are veneered with thin alluvium of Holocene age. The flood of 1937 is believed to have formed a lake approximately the size of the Wisconsinan glacial lake that existed during the time of the Maumee Torrent.

The exposure in the ditch that is tributary to Cypress Ditch shows the types of sediments deposited here in late glacial times and later. The shells and humus material in the deposits are evidence of the animal and plant life that existed while the deposits accumulated along low-gradient streams or in ponds or lagoons on the outwash. The section here is as follows.

	Feet	Inches
Soil, gray, silty, with mollusks..............		6-12
Silt, tan to buff, finely laminated contains a few thin humic laminae...........		4-6
Alluvium, dark gray-black, irregular top and bottom, humic zone in part contoured.....		4-8
Silt, tan-buff, faintly laminated, very fine with some dark concretions, probably due to the presence of iron oxide...............		4-15
Alluvium (buried), dark brownish gray, with much humic material, upper 10 inch portion has tan to buff silt, with many snails and clams......................................	1-2	
Silt, blue-gray, clayey, calcareous, fossiliferous...............................	1-2	
Marl, silty, blue-gray........................		8-12
Silt, clayey, blue-gray		

Miles to Next Stop	**Miles from Start**	
0.0	8.3	Leave Stop 3. Re-enter road with caution. CONTINUE AHEAD (northerly).

Miles to Next Stop	Miles from Start	
0.05	8.35-	Cross Cypress Ditch and CONTINUE AHEAD (north).
0.65+	9.0-	CAUTION: Cross bridge. Note oil well tank batteries in this area.
0.85	9.85-	Prepare to turn right.
0.1+	9.95	TURN RIGHT: T-road intersection, just as the road straightens out beyond the curve. You are just south of the steel electric transmission lines.
0.6+	10.55+	CAUTION: little offset in the road across a culvert and a ditch. Sides are not marked. Even with the ditch you may notice that the fields on either side are very poorly drained and frequently have water standing in them. Some of the higher elevations in here are on sand bars that developed during the Maumee Torrent mentioned at Stop 3.
0.4+	11.0+	To the right about one-quarter mile is an oil well pump jack.
0.1	11.1+	Park along roadside to the right near the oil tank battery. CAUTION: deep ditch to right.

STOP 4. Discussion of Junction East Oil Pool, [NW 1/4 NW 1/4, Sec. 1, T. 9 S., R. 9 E., 3rd P.M.; New Haven SW 7.5-minute Quadrangle (37088G2)].

The diagram in the MISSISSIPPIAN DEPOSITION appendix shows a large bird's-foot delta at the mouth of the Michigan River from which sand, silt, and mud were being dumped into the Illinois Basin much as modern sediments pass through the Mississippi Delta on their way to the Gulf of Mexico. The upper Mississippian (Chesterian) Waltersburg Sandstone (fig. 10) was deposited as distributary channel sands (fig. 11) in a deltaic environment (fig. 12) and occurs in southeastern Illinois, southwestern Indiana, and western Kentucky. This formation generally ranges from 50 to 75 feet thick. In addition to the sandy facies, the formation also consists of silt and shale.

The Junction East Oil Pool (fig. 13) was discovered in 1953 when the McBride and Miller #1 Crane well (Sec. 1-9S-9E-3PM) was completed in the Waltersburg at a depth of 2,000 feet. Secondary recovery of oil began in March 1968. Cumulative production has amounted to 171,000 barrels of oil.

The #2 well of the Crane Lease is situated in the SW 1/4 NW 1/4 NW 1/4 Sec. 1, about 1,000 feet south of the road and southwest of the tank battery. It was completed in the Waltersburg Sandstone at a depth of 2,000 feet during November 1971, with an initial production of 58 barrels of oil and 40 barrels

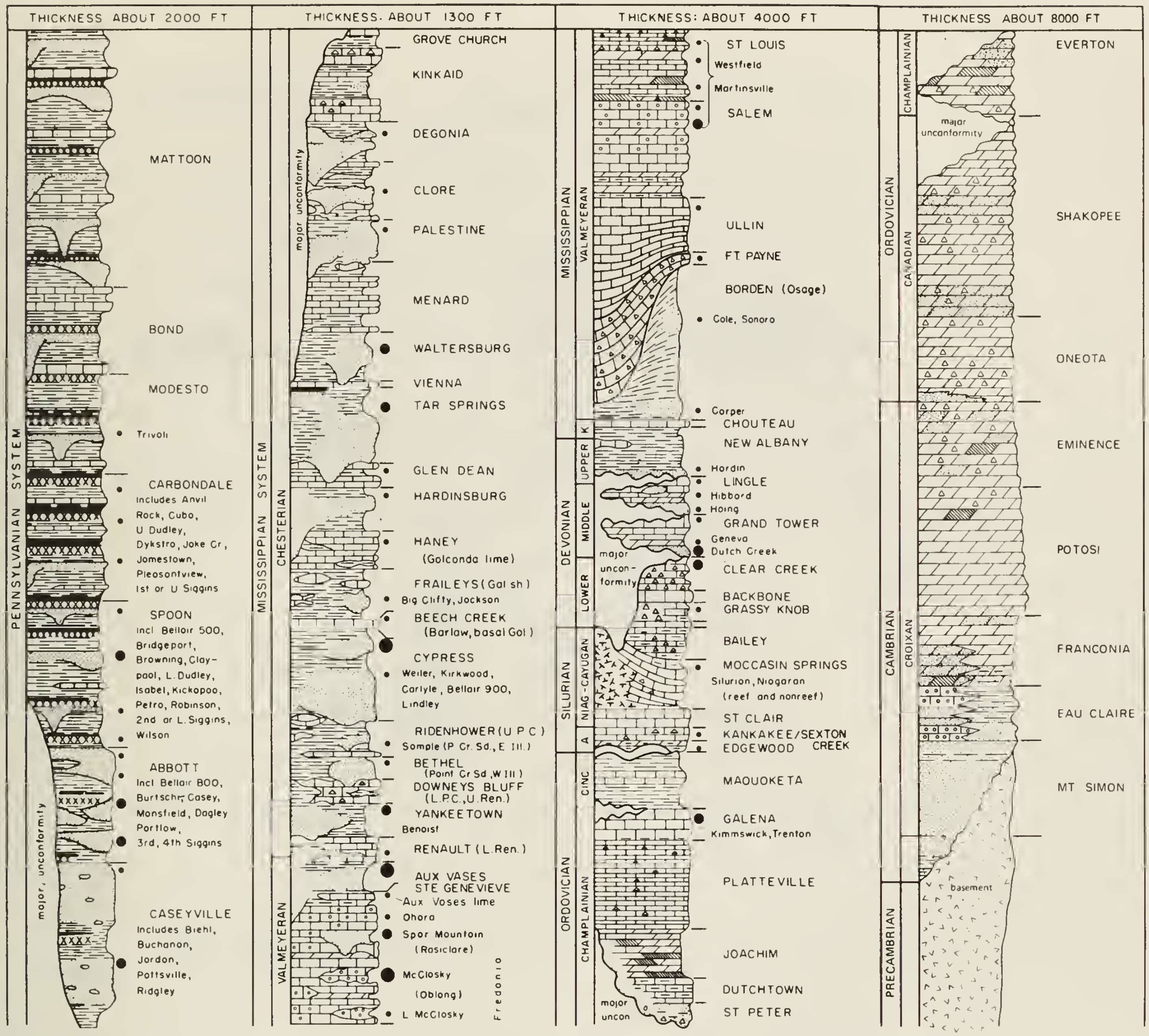


Figure 10 Generalized geologic column of southern Illinois. Solid dots indicate oil and gas pay zones. Formation names are in capitals; other pay zones are not. About 4,000 feet of lower Ordovician and upper Cambrian rocks under the St. Peter are not shown. The names of the Kinderhookian, Niagaran, Alexandrian, and Cincinnatian Series are abbreviated as K., Niag., A., and Cinc., respectively. Variable vertical scale. (Originally prepared by David H. Swann.)

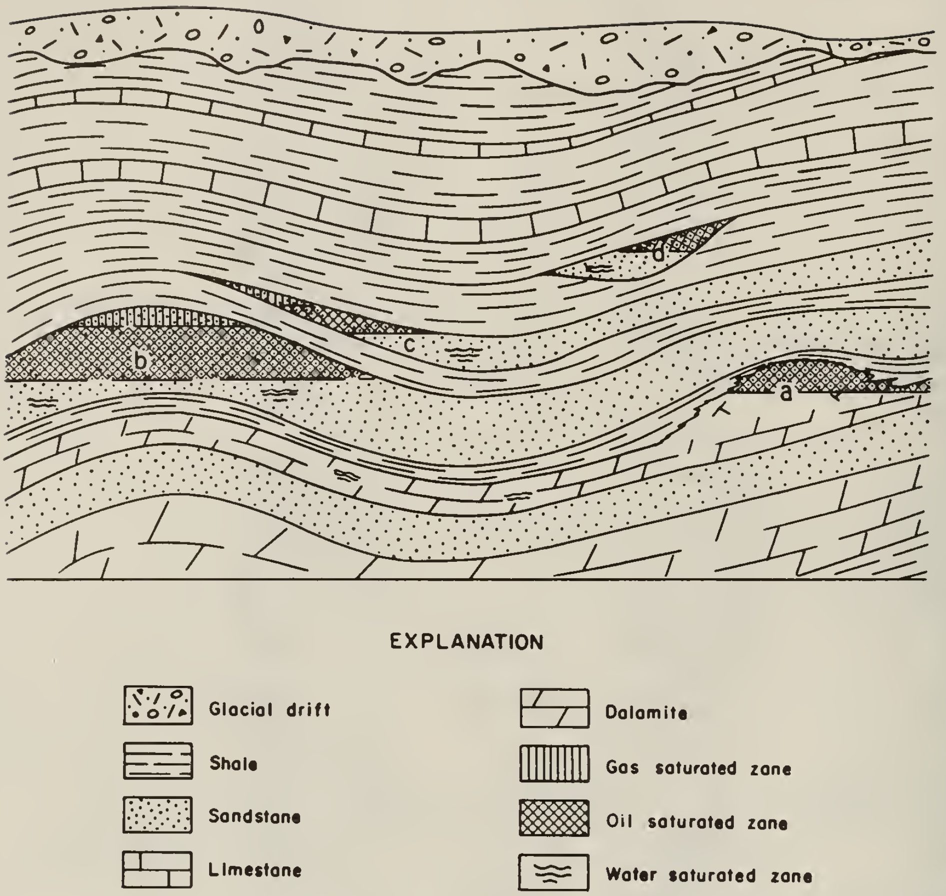


Figure 11 Places where oil is found in Illinois: (a) coral reefs, (b) anticlines, (c) pinch-outs, and (d) channel sandstones.

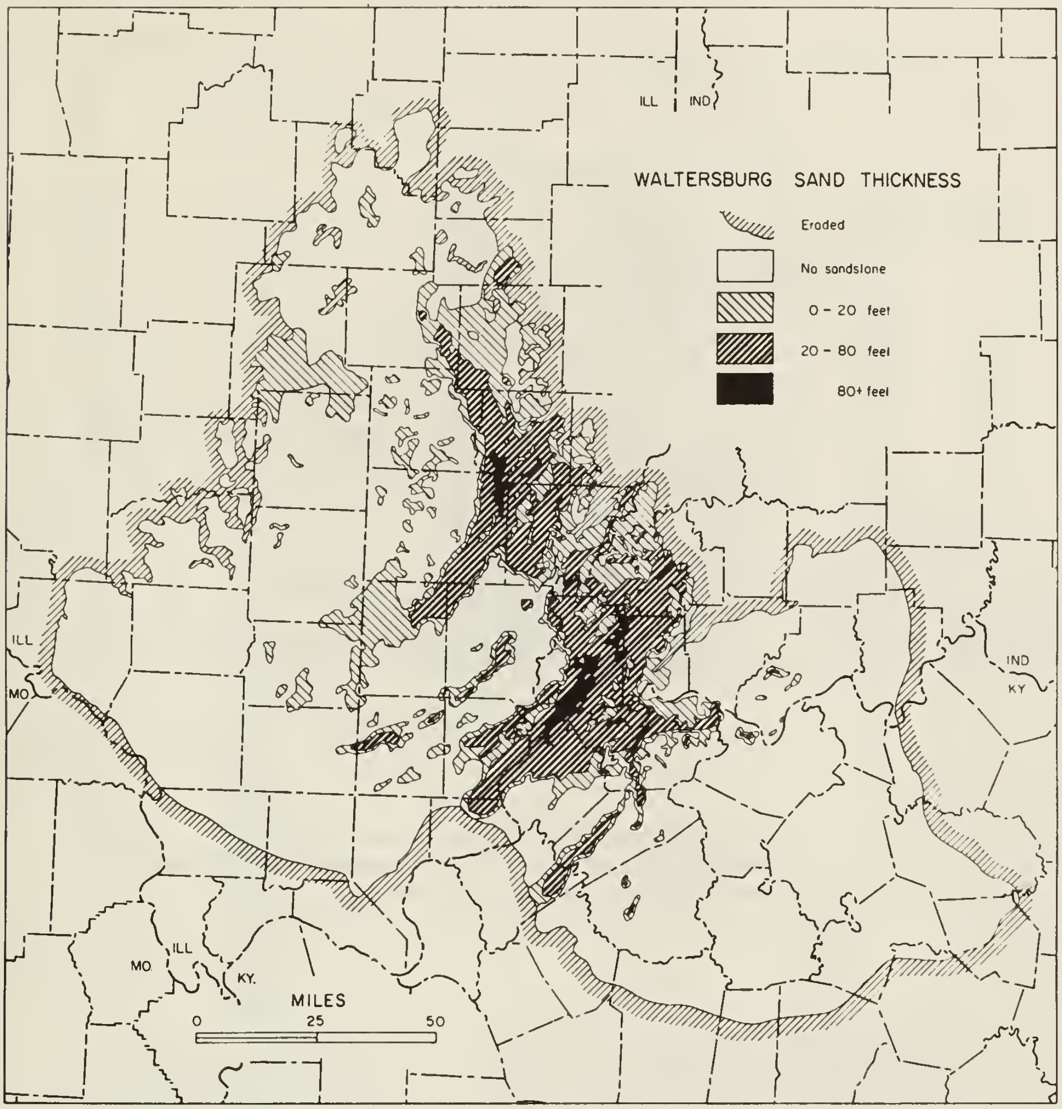


Figure 12 Total thickness of sandstone in Waltersburg Formation as determined from electric logs. (Simplified from Potter, 1962, by Swann, 1964).

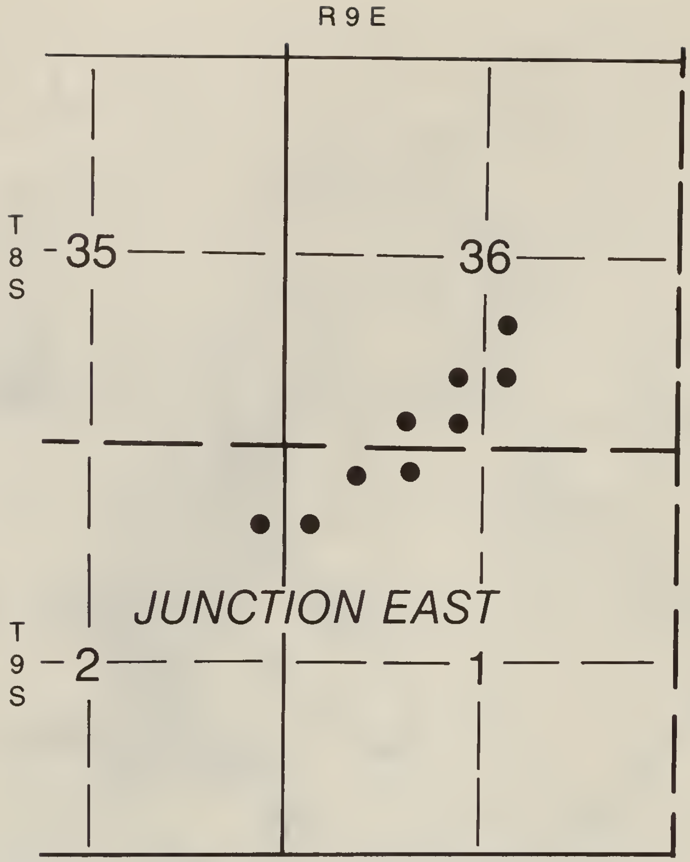


Figure 13 Producing wells in the Chesterian Waltersburg Sandstone, Junction East Oil Pool, Gallatin County, Illinois.

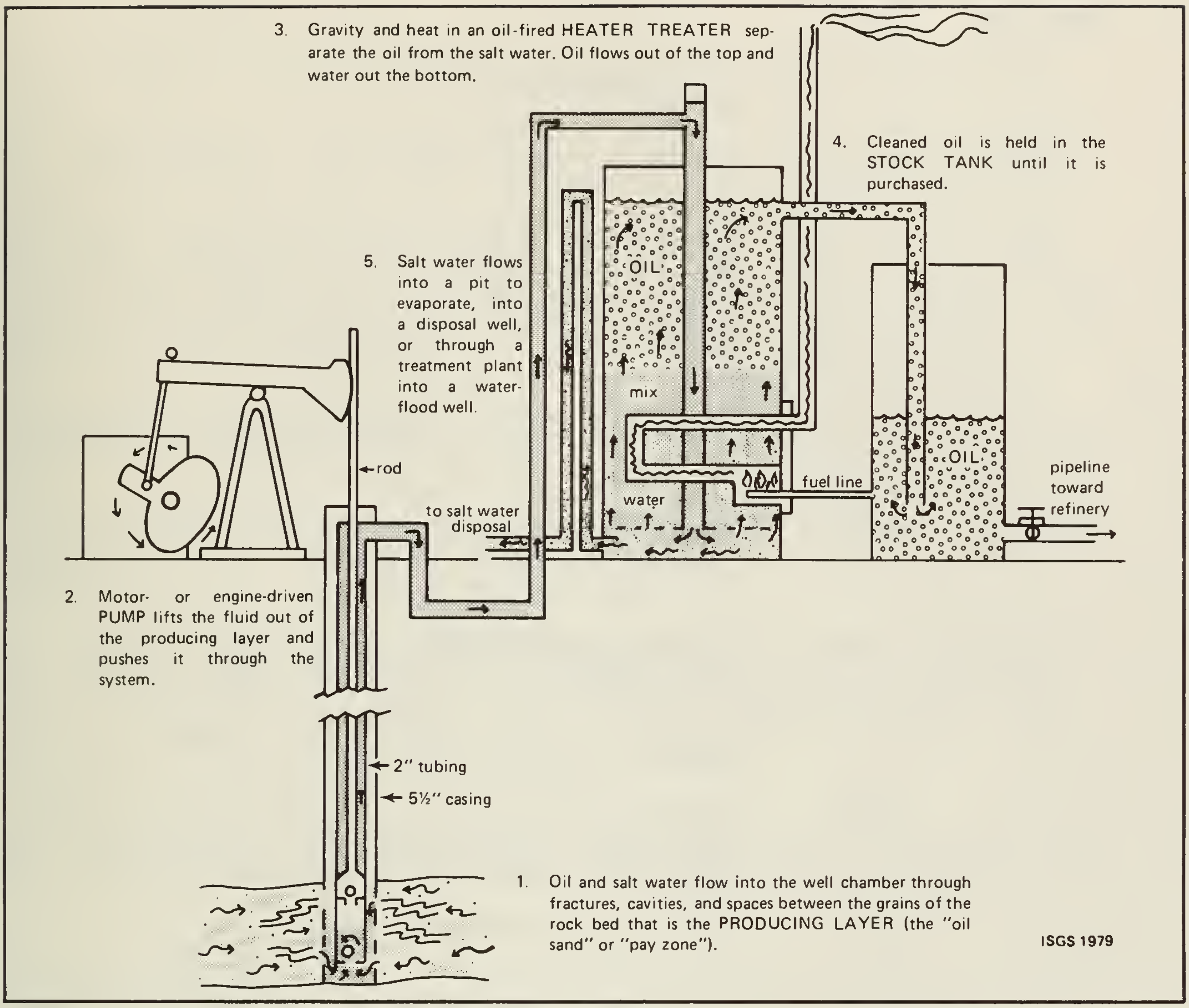


Figure 14 Schematic diagram of a common type of oil production unit in Illinois.

of water per day. Fluids from this well are pumped to this tank battery for separation of oil and water and storage of the oil (fig. 14). The cumulative production for the wells in the Crane Lease is approximately 36,000 barrels of oil.

Miles to Next Stop	Miles from Start	
0.0	11.1+	Leave Stop 4 and continue ahead east.
0.05+	11.2	CAUTION: Culvert sides not marked.

Miles to Next Stop	Miles from Start	
0.3	11.5	To the right is one of the sand bars on the Maumee Terrace.
0.9+	12.4+	CAUTION: T-road intersection. CONTINUE AHEAD (east).
0.2-	12.6	Cross Cattail Slough outlet. This outlet drains to the left (northeast) for about 4 miles to the Wabash River. The slough is about 0.7 miles long. The southwest outlet is via Cypress Ditch to the Saline River.
0.55	13.15+	CURVE RIGHT (south). The confluence of the Wabash and Ohio Rivers is about 6.1 miles east-northeast of this curve.
0.9+	14.1+	T-road intersection. CONTINUE AHEAD (southerly). The road ahead cuts through the toe of several hills and exposes lacustrine silts.
1.25	15.35+	The route passes through several good loess exposures in ascending the hill ahead.
0.4+	15.8+	T-road from left. CONTINUE AHEAD (southerly) downhill and prepare to stop.
0.1	15.9+	The downhill segment of this road is incised into thick loess. This is one of the best roadcut exposures through loess in this area.
0.1	16.0+	Park on the right as far as you can safely.

STOP 5. Discussion of loess in roadcut exposure [NW 1/4 SW 1/4 SW 1/4, Sec. 17, T. 9 S., R. 10 E., 3rd P.M.; Shawneetown 7.5-minute Quadrangle (37088F2)].

As mentioned earlier, during glacial winters when very little melting of the ice mass occurred, meltwater streams subsided drastically exposing large expanses of outwash plains and valley trains to the strong, drying winds that blew across these barren deposits. The fine-grained particles, such as sand, silt, and clay, were dried off rapidly and then picked up by the wind. When the wind was deflected upward by an obstacle or by convection currents, it no longer was able to carry the sand and thus dropped it. Silts and clays (loess, pronounced "luss") were carried farther by the wind because of their smaller size and weight. They too, however, began to settle out within short distances of the valleys to blanket the uplands. Far from the large streams, long term accumulation of loess can be measured only in inches, if

recognizable at all. Loess is as much as 80 feet thick on some of the higher areas of Shawneetown Hills.

As noted earlier (mileage 15.9+), this is an excellent roadcut exposure of loess. When dry loess has high strength but it will shear in vertical slabs and fall onto the roadway unless adequate drainage of the lower part of the cut is maintained. Incised roadways through valley bluffs were very common during the horse and buggy days. Roads generally did not have any surfacing and the wagon wheels and animal hoofs continually disaggregated the friable silts and clays permitting the material to be flushed away during the next heavy rain. Many of these old roads were barely wide enough for the wagons to pass through. In our modern approach to road cuts through this material, we tend to go to the other extreme--we make the roadcuts wide and then we slope the sides so that hopefully we can get a good stand of grass on them. Unfortunately for road maintenance, this does not work at all well because when loess is cut on an angle it becomes unstable and very susceptible to slumping. At first the slumps are small, but they do increase in size as time passes. Interestingly enough, the back of the slump, the scarp, is nearly vertical. In other words, slumping helps to "heal" the damage done from angle cutting in that the making of new vertical faces with the removal of the foot or slumped material leads to the establishment of a new equilibrium for the exposure.

Survey geologist Paul MacClintock, working in this area in 1925, commented on this exposure,..."as good loess as I ever saw..." We can still attest to that. The following description is from Survey geologists Willman and Frye (1972), the numbers in parentheses refer to their samples:

SHAWNEETOWN HILLS NORTH AND SOUTH SECTIONS

Composite of sections in roadcuts in SW 1/4 SW 1/4 NW 1/4 Sec 17, T. 9 S., R. 10 E., and in NW 1/4 SW 1/4 SW 1/4 Sec. 17, T. 9 S., R 10 E., Gallatin County Illinois (1971).

Pleistocene Series
Wisconsinan Stage
Woodfordian Substage
Peoria Loess

6. Loess, leached, coarse, loose; upper half poorly exposed (P-7415, lower) . . . . 7 to 10.0

5. Loess, calcareous, coarse, massive, tan; contains fossil snail shells in lower part (P-7418, 1 foot above base; P-7419, 5 feet above base). 20.0

4. Loess, calcareous, massive, tan to light brown, fossiliferous; contains large polygyrid shells that are not present in overlying bed (P-7414, upper part; P-7413, lower part); shells from the base of this unit at The Rocks Section, directly across the Ohio River Valley from Shawneetown, were dated 22,200 ± 450 (W-867) B.P.; partly leached transition zones at bottom 2.5

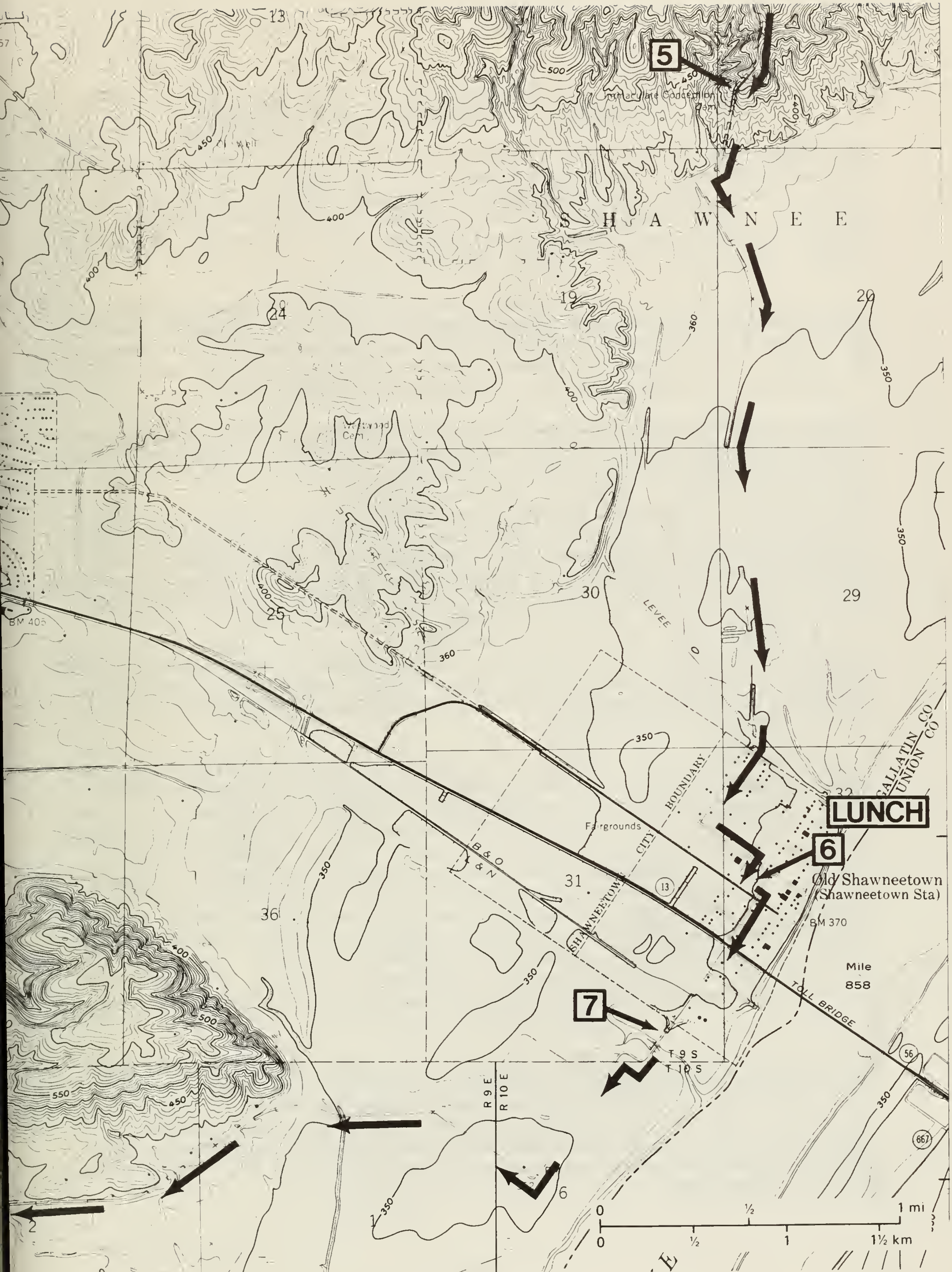
Altonian Substage
Roxana Silt
3. Colluvium of silt containing dispersed chert pebbles, leached, reddish brown grading upward into brown, massive (Farmdale Soil); (P-7412) 1.0

Pliocene-Pleistocene Series
Mounds Gravel
2. Gravel of chert and quartz containing well rounded pebbles up to 3 inches in diameter, leached, massive; matrix of red-brown clay and silt fills all interstices (P-7411), 1/2 foot below top). . 3.0

Pennsylvanian System
1. Shale to bottom of exposure --

Total 35.0

Miles to Next Stop	Miles from Start	
0.0	16.0+	Leave Stop 5 and CONTINUE AHEAD (south-southwest).
0.2+	16.25	T-road from left. CONTINUE AHEAD (south-southwest) and curve right (southwest) across Ohio River floodplain.
0.1+	16.35+	T-road from left. TURN LEFT (southeast).
0.25	16.6+	To the right is the southern extension of the Shawneetown Hills.
1.5	18.1+	Note all the indiscriminant dumping along the roadway on both sides.
0.1	18.2+	CAUTION: Ascend levee and prepare to curve right on the other side of the levee. At the base of the levee, enter Old Shawneetown.
0.2+	18.4+	STOP: 3-way. CONTINUE AHEAD (southwest).
0.2	18.6+	Street intersection. TURN LEFT (southeast).
0.2	18.8+	STOP: 4-way. TURN RIGHT (southwest).
0.05	18.85+	TURN LEFT (southeast) into the driveway at the picnic area.
0.05	18.9+	Park in the parking area provided.


5
Immaculate Conception Cem
S H A W N E E
Westwood Cem
LEVEE
Fairgrounds
SHAWNEETOWN CITY BOUNDARY
B & O
L & N
LUNCH
6
Old Shawneetown
(Shawneetown Sta)
BM 370
Mile
858
GALLATIN CO
UNION CO
TOLL BRIDGE
7
T 9 S
T 10 S
R 9 E
R 10 E
BM 405
0
½
1 mi
0
½
1
1½ km

STOP 6. Lunch. [SW 1/4 SW 1/4 NW 1/4, Sec. 32, T. 9 S., R. 10 E., 3rd P.M.; Shawneetown 7.5-minute Quadrangle (37088F2)].

The Shawnee Indians were the first known inhabitants in the vicinity of what is now Shawneetown. A number of houses in the old town were built on low mounds that turned out to be Indian burial mounds, either those of the Shawnees or their predecessors. The first white settler arrived in 1797. A special act of Congress directed that the town be surveyed in 1810 (Bonnell, 1946).

Territorial Governor Ninian Edwards signed the enabling document for the establishment of Gallatin County on September 14,1812. This was the 5th county designated in the Northwest Territory and it embraced all or parts of 16 present-day southeastern Illinois counties. Governor Edwards designated "Shawnee Town to be the seat of justice in Gallatin County."

Although a government land office was established in Shawneetown in 1812, it was not until 1814 that the first land sale was recorded. The town was first incorporated on December 8, 1814, and then again on May 22, 1874.

The first bank building in Illinois was established in Shawneetown in 1812. From Stop 6, the old two-story brick bank is situated 1-1/2 blocks southeast and then about 2 blocks to the right (southwest) next to the levee and the Ohio River bridge. According to reports that appear to be factual, shortly after the bank was established, it refused a loan request from Chicago which at that time was a much smaller settlement than Shawneetown!

The tall bank building with large Doric columns across the front located about 1-1/2 blocks southeast of here was built in 1840. Soon after it was established, it loaned the State of Illinois, $80,000 for use in constructing the Capitol building in Springfield.

Flooding has been a major problem throughout the history of Shawneetown. A number of severe floods finally led to the construction of a levee in the 1860s. Disastrous floods in the 1880s, when the river crested 66 feet above its low-water mark, led to building the levee higher. The Federal Government finished a still later rebuilding of the levee in 1933. However, the 1937 flood on the Ohio topped the levee leaving only a few building roofs above water. As noted previously, this flood was so extensive that it has been thought to be about the same magnitude and extent as glacial Lake Saline. As a result of the 1937 flood, a government project was directed toward moving the town to higher ground. A number of the homes were moved. A new courthouse and jail were constructed in the new part of town. A connecting strip between the two parts of town eliminated any need to change the local government.

Present-day SR 13 occupies land that was quite swampy during the early days. Then, settlers moving westward used roads across Gold Hill and the Wildcat Hills farther west beyond the Saline River. Ridge top roads and trails dried out first in the spring, and after the heavy rains. Portions of these old roadways are still discernible, especially where they cut down through the loess. Old home and inn sites have been found and studied along the road over Gold Hill (Dyhrkopp).

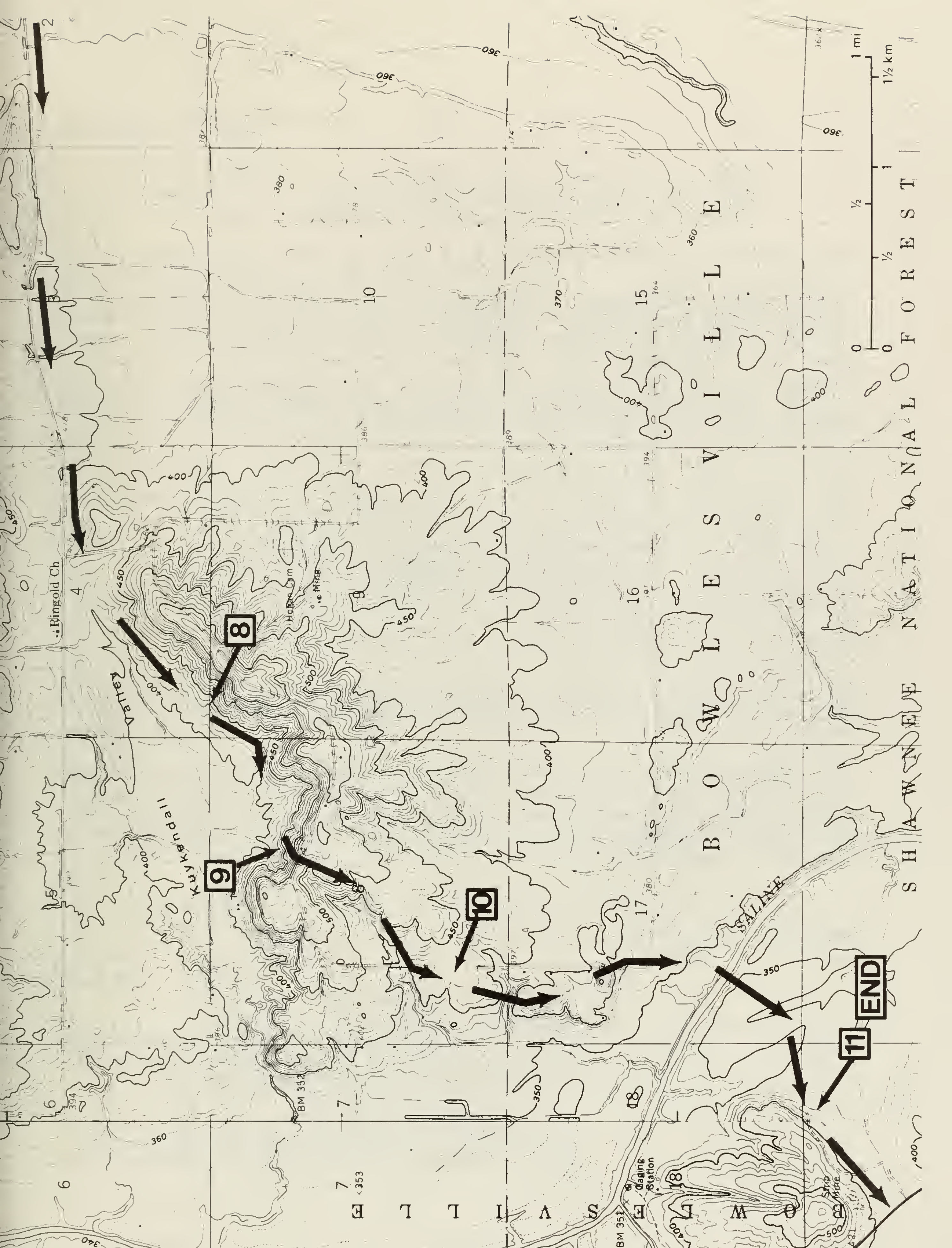
Miles to Next Stop	Miles from Start	
0.0	19.55+	Leave Stop 7 and CONTINUE AHEAD (southwest).
0.25	19.8+	To the right (northwest) is the conveyor belt that comes from Eagle #1 Mine to the junction/transfer station.
0.5	20.3+	To the left is another non-permitted refuse dumping area on a sand bar.
0.65	20.95+	CAUTION: Narrow one-lane bridge; no side rails.
0.15+	21.15+	CAUTION: Intersection with blacktop road around the east end of Gold Hill. This intersection is on a curve of the blacktop. CONTINUE STRAIGHT AHEAD (westerly) onto the blacktop. Fast traffic and the visibility is somewhat restricted.
0.6-	21.75	You are going along the south side of Gold Hill. View toward the left is across the floodplain of the Ohio River.
0.25+	22.0+	T-road intersection from left. CONTINUE AHEAD (westerly).
0.1+	22.15+	CAUTION: Narrow culvert; sides not well marked.
0.35	22.5+	T-road from left. CONTINUE AHEAD (westerly).
0.5+	23.05	Another narrow culvert with no side markings. CONTINUE AHEAD (westerly). The road ahead is pretty rough in a few places.
0.6	23.65-	Another narrow culvert; unmarked.
0.1+	23.75	Inverted "r"-intersection. BEAR LEFT (southwesterly). This will be along the left side of the conveyor belt on a mine road.
0.2	23.95	CAUTION: Crossroad. CONTINUE AHEAD on the mine road toward Eagle #1 Mine.
0.05	24.0	Gate to Peabody Coal Company Eagle No. 1 Mine property. You are on a private mine road. **NO** trespassing without permission.
0.65	24.65	CAUTION: You are entering the Eagle #1 office and tipple area. Park along the right side of the mine road as far outside of the traffic pattern as is possible.

Miles to Next Stop	Miles from Start	
0.0	18.9+	Leave Stop 6. CONTINUE AHEAD (southeast).
0.05	18.95+	TURN RIGHT (southwest).
0.05	19.0+	STOP: 2-way, crossroad. CONTINUE AHEAD (southwest). To the left is the Shawneetown State Historic Site office. CAUTION: the road ahead is rough because it receives a lot of heavy truck traffic.
0.15+	19.2	Underpass beneath Highway 13 Ohio River bridge approach. CONTINUE AHEAD. Be CAUTIOUS of large trucks in this area. Go straight ahead and up the road over the levee and under the conveyor belt.
0.25	19.45	To the right is the entrance to Eagle Loading Dock that handles the coal from the mines. CONTINUE AHEAD (straight) and ascend the levee.
0.05	19.5	You are going under the conveyor belt that carries coal to the barge loading facility to the left.
0.05+	19.55+	Park along roadside near lane outlet from loading dock. Be careful of 2-way traffic here. Do NOT block access to loading dock lane.

STOP 7. Peabody Coal Company Loading Dock. [NW 1/4 SW 1/4 SE 1/4 SE 1/4 Sec. 31, T. 9 S., R. 10 E., 3rd P.M.; Shawneetown 7.5-minute Quadrangle (37088F2)].

The loading dock is situated about 0.25 mile to the southeast at the end of the lane. This facility was constructed in the mid-1960s to transfer coal from Peabody Coal Company mines to river barges for shipment to electric power generating facilities.

Clean coal is brought from the Eagle No. 1 Mine tipple about 5 miles to the west-southwest via a 42-inch wide conveyor belt system to a junction/transfer facility located north of us, inside the levee. This transfer station also receives coal via a company-owned diesel-powered unit train from Eagle No. 2 Mine located about 5 miles to the northwest. Coal is moved from the junction/transfer station via a 72-inch wide conveyor belt to the loading dock which has a loading capacity of 3,000 tons per hour. Barges loaded here have an average capacity of 1,500 tons. On a good day, 8 barges of coal can be loaded. Company tugs move the barges about getting them ready for pick up by a large river towboat.



Bingold Ch
Kuykendall Valley
BOWLESVILLE
SHAWNEE NATIONAL FOREST
SALINE
8
9
10
11
END
Gaging Station
Strip Mine
BM 352
0
½
1 mi
1½ km

STOP 8. Peabody Coal Company Eagle No. 1 and Eagle Strip Mines. [NE 1/4 NW 1/4 NW 1/4 NW 1/4 Sec. 9, T. 10 S., R. 9 E., 3rd P.M.; Shawneetown 7.5-minute Quadrangle (37088F2)].

The office of this abandoned mine is just ahead to the southwest and the tipple is just behind it. The Eagle Strip Mine started producing coal in 1966 from the Herrin Coal Member of the Carbondale Formation. According to the Coal Reports of the Illinois Department of Mines and Minerals, the Herrin Coal was mined exclusively for about 8 of the years that the mine operated. More than 4.19 million tons of Herrin Coal were mined from this seam. The Herrin averaged about 3 feet 5 inches thick and occurred at depths ranging from 20 to 80 feet. The Davis and Dekoven Coal Members of the Spoon Formation were mined exclusively for three of the 14 operating years and yielding more than 1.22 million tons of coal. For two years the mine produced in exess of one million tons from 5 different coal seams (from youngest to oldest): Herrin, Briar Hill, Springfield, Dekoven, and Davis coals. Average thicknesses of these coals ranged from 2 feet 6 inches for the Briar Hill, to 3 feet to 3 feet 6 inches each for the Herrin, Dekoven, and Davis, and up to 4 feet 6 inches for the Springfield. The coals were not mined from a single pit, but rather from several different pits to the south, southwest, and west of the tipple. Overburden thicknesses ranged from 20 to 80 feet depending on the location of the pit in relation to the structure of Eagle Valley (the structure will be discussed more fully at Stop 10). Total coal produced from this surface mine was 6,475,655 tons by the time the mine was abandoned in 1980.

Eagle No. 1 Mine was a slope mine that operated exclusively in the Springfield Coal, which averaged 4 feet 6 inches thick. This underground mine, which operated from March 1967 through March 1974, produced 5,131,198 tons of coal.

The coal from these two mines was processed at the tipple just ahead, and then carried on the conveyor belt, mentioned earlier, to the Eagle Loading Dock at Stop 7. Other coal mine operators truck coal to this tipple from mine sites several miles to the west. The clean coal is transported via this conveyor belt to the Loading Dock area.

Miles to Next Stop	Miles from Start	
0.0	24.65	Leave Stop 8. CONTINUE AHEAD (southwest).
0.1	24.75	CAUTION: keep to the far left around the office and tipple area. There is an open hopper large enough to swallow your car <u>if</u> you aren't careful.
0.2	24.95	USE EXREME CAUTION--BEAR RIGHT at the fork in the road and get on the haulage road west of the open hopper. TURN LEFT as soon as you are on the haulage road.

Miles to Next Stop	Miles from Start	
0.3	25.25	Park along the right side of the haulage road. Do NOT climb up the rock faces.

STOP 9. Strata of the Carbondale Formation below the basal part of the Herrin Coal Member. [SE 1/4 SW 1/4 NW 1/4 NE 1/4 Sec. 8, T. 10 S., R. 9 E., 3rd P.M.; Shawneetown 7.5-minute Quadrangle (37088F2)].

At the top of this roadcut, the Herrin Coal has been mined from both sides of the road. Some of the basal coal can still be found beneath slumped spoil material. The following section was described by Berggren and Nelson (1981):

Base of Herrin Coal	
Underclay	3'
Sandstone, light gray	6-8'
Shale, upper portion very silty, becomes darker gray and less silty downward, contains rounded siderite nodules in lower portion	30'
Covered interval - probably contains Briar Hill Coal	10'
Sandstone noted in ditch below covered interval	

This shale appears to be in part equivalent to the Canton Shale of western Illinois. There, in its type area in Fulton County, the Canton Shale overlies the St. David Limestone just above the Springfield Coal, and may be as much as 50 feet thick.

Here we are on the north limb of the Kuykendall Anticline, a small upwarp affecting a few square miles just south of the western end of Gold Hill. The axis of this flexure trends slightly south of east here, but within about half a mile to the east, it curves sharply northeastward. Although it is difficult to recognize much dip here, just to the west dips of a few degrees have been measured.

Miles to Next Stop	Miles from Start	
0.0	25.25	Leave Stop 9 and CONTINUE AHEAD (southwesterly) and ascend hill.
0.7+	25.95+	Park as far to the right side of the haulage road as you safely can.

STOP 10. View to west of part of Eagle Valley Syncline. [Near Center NE 1/4 SW 1/4 SW 1/4 Sec 8, T. 10 S., R. 9 E., 3rd P.M.; Shawneetown 7.5-minute Quadrangle (37088F2)].

This vantage point affords a good view of some of the sandstone ridges that rim Eagle Valley on the north, west, and south, although those to the south are somewhat obscured from here. To the northwest, west of Gold Hill, are the Wildcat Hills, which traces westward into Cave Hill at the northwest and west end of the valley. South from Cave Hill is Horton Hill, more than 980 feet m.s.l. elevation. The south rim is partly obscured by the smaller inner ridge slightly southwest of this locality. The sandstone ridges of the south rim, however, have many places well known for their scenic vistas, such as, Garden of the Gods, High Knob, and Pounds Hollow, from west to east.

These sandstone ridges outline a large bedrock trough or syncline called Eagle Valley Syncline. A syncline is a fold in which the bedrock layers have been bent downward by compressive forces acting within the earth's crust. The strata on both sides or limbs of a syncline dip (tilt) inward toward the axis or lowest part of the fold. Along the axis or central part of an eroded syncline, the youngest folded rocks are exposed. The opposite of a syncline is an anticline, in which the strata are bent upward into an arch. We are situated just southwest of the axis of the Kuykendall Anticline.

Eagle Valley Syncline is an asymmetrical fold in which the strata on the north limb dip more steeply than the strata on the south limb. Average dips are about 5 degrees on the south and 20 degrees on the north. The ridges that outline the syncline are formed by the eroded, upturned edges of resistant Lower Pennsylvanian sandstone. These sandstones consist principally of massive sandstones of the Caseyville Formation, which form steep, outward-facing cliffs along much of their outcrop belt. The top of this erosional escarpment is capped by the Grindstaff Sandstone of the Abbott Formation. Eagle Valley itself is eroded in the softer shales and shaly sandstones that occur above the Grindstaff. The Gimlet Sandstone of the Modesto Formation is also resistant to erosion and forms the low hills in the central part of the valley along the axis of the syncline.

According to Nelson and Lumm (1987), the axis of the Eagle Valley Syncline is sinuous and does not exactly parallel the limbs of the structure. The axis plunges (is tilted downward) to the east, and the syncline is deepest and widest near the Ohio River. The eastward extension of the Eagle Valley Syncline in Kentucky is the Moorman Syncline where the youngest preserved Pennsylvanian strata in the Illinois Basin are found within a short distance from the river.

The features noted today are largely formed after early Permian time, based on rocks of Permian age that were deformed in Union County, Kentucky. Movement along some of the faults occurred earlier during the Pennsylvanian Period and probably even as early as the Cambrian Period. Nelson and Lumm feel that major movements are most likely pre-Cretaceous in age, and they have found no evidence of Pleistocene tectonic movements in this region.

Miles to Next Stop	Miles from Start	
0.0	25.95+	Leave Stop 10. CONTINUE AHEAD (southerly).
0.65+	26.65+	CAUTION: southwest gate to Peabody Coal Company property. Just beyond the gate is a T-road intersection from the left. CONTINUE AHEAD (southwesterly) on the haulage road.
0.25	26.9+	CAUTION: enter one-lane bridge across Saline River. Trucks have the right-of-way!
0.65	27.55+	Park as far to the right as you safely can near the lane opening with the Peabody sign, "Stop. Do Not Enter."

STOP 11. Carbondale Formation strata exposed in abandoned surface mine highwall. [Lane entrance: NW 1/4 NW 1/4 NE 1/4 NE 1/4 Sec. 19, T. 10 S., R. 9 E., 3rd P.M.; Shawneetown 7.5-minute Quadrangle (37088F2). NOTE: to better understand the relation of the mine to the surface topography here, see also Equality 7.5-minute Quadrangle (37088F3)].

Springfield Coal was mined from this abandoned pit. Perhaps some Briar Hill Coal may also have been removed from this pit. Farther to the northwest, some Herrin Coal was mined from the top part of the hill. This highwall shows some of the same strata that we saw at Stop 9. From this outcrop you can gain an appreciation of how rapidly the rock units can change over small vertical and horizontal distances. The following described section is modified from Berggren and Nelson field notes:

Sandstone (Vermilionville?), light gray weathering yellowish-brown, fine to medium-grained, quartzose, slightly micaceous, moderately well cemented, bedding thick and irregular, discontinuous irregular laminations, basal contact sharp and definitely erosional	20-25'
Canton Shale, medium-dark gray, very thinly laminated, soft, finely silty, contains thin laminae of purplish-weathering siltstone, very uniform throughout, basal 4 inches or so softer and less distinctly laminated. Fairly sharp basal contact with:	5-15'
Shale, black, papery, yellowish efflorescence on surface, sharp basal contact	4"
Briar Hill Coal, normally bright banded, yellowish efflorescence, discontinuous shaly partings in basal portion	3' 4"
Claystone, medium-dark gray, soft, finely silty, quite carbonaceous with coal stringers. Grades into:	6"

Shale and siltstone, medium-dark gray, weathers brownish-orange, moderately firm, finely micaceous and carbonaceous, very indistinct beds of nodular siltstone, unit becomes more distinctly laminated toward base. Grades into:	1' 6"
Shale, medium-dark gray, thinly laminated, silty, finely micaceous and carbonaceous, contains scattered thin lenses of brownish weathering siltstone	8'
Water level/covered interval	?'
Springfield Coal	

About 500 feet west of the above section Berggren and Nelson described the following section below the coal:

Briar Hill Coal, weathered, poorly exposed	2-3'
Sandstone, light to medium gray, fine-grained, coarsely micaceous with abundant plant debris, upper half is very argillaceous and appears reworked, lacks laminations; lower half is well bedded with interlams of siltstone. Sharp basal contact	1' 6"
Shale, medium-dark gray, thinly laminated, finely silty, contains many lenses and bands of reddish brown weathering siltstone, lenses up to 2 inches thick and 6 inches to 1 foot apart	40'
St. David Limestone, dark gray, very fine-grained, hard, consists of nodules or lenses several inches thick in a matrix of dark gray, calcareous shale that weathers reddish to yellowish-brown	6"
Shale, black, smooth, thinly laminated, platy, extends below water	4"

A small normal fault is located in the western part of the pit. Displacement is about 1.5 feet in the coal, but appears to increase to nearly 5 feet in the Vermilionville(?) Sandstone.

There are a few scattered pieces of limestone on the south side of the pond. Most of these have some fossil remains.

Miles to Next Stop	**Miles from Start**	
0.0	27.55	End of field trip. Leave Stop 11. CONTINUE AHEAD (westerly) about 0.4 miles to SR 1. TURN LEFT (southerly) to Pounds Hollow, Garden of the Gods, Cave in Rock, etc. TURN RIGHT (northerly) for SR 13 and Shawneetown, Harrisburg, etc.

REFERENCES

Anonymous, 1966-1980, Coal Reports: Illinois Department of Mines and Minerals Annual Report, 250± p.

Anonymous, 1984, Gallatin County: Illinois State Geological Survey Coal Mines Maps and Directories, 4 p.

Berggren, D. J., and W. J. Nelson, 1981, Miscellaneous Gallatin County Mine Notes: Illinois State Geological Survey Coal Section Mine Notes.

Bonnell, Clarence, 1946, The Illinois Ozarks: (privately published), 156 p.

Bristol, H. M., and J. D. Treworgy, 1979, The Wabash Valley Fault System in Southeastern Illinois: Illinois State Geological Survey Circular 509, 19 p.

Dyhrkopp, Frances, ca. 1980, A History of Gold Hill: privately published and circulated, 7 p.

Fidlar, M. M., 1948, Physiography of the Lower Wabash Valley: Indiana Geological Survey Bulletin 2, 112 p.

Frye, J. C., and A. B. Leonard, H. B. Willman, and H. D. Glass, 1972, Geology and Paleontology of Late Pleistocene Lake Saline, Southeastern Illinois: Illinois State Geological Survey Circular 471, 44 p.

Frye, J. C., and H. B. Willman, 1970, Pleistocene Stratigraphy of Illinois: Illinois State Geological Survey Bulletin 94, 204 p.

Horberg, L., 1950, Bedrock Topography of Illinois: Illinois State Geological Survey Bulletin 73, 111 p.

Howard, R. H., 1967, Oil and Gas Pay Maps of Illinois: Illinois State Geological Survey Illinois Petroleum 84, 64 p.

Leighton, M. W., G. E. Ekblaw, and L. Horberg, 1948, Physiographic Divisions of Illinois: Illinois State Geological Survey Report of Investigations 129, 19 p.

Lineback, J. A., 1979, Quaternary Deposits of Illinois: Illinois State Geological Survey Map; scale, 1:500,000; size, 40 x 60 inches; color.

Nelson, W. J., and D. K. Lumm, 1986, Geologic Map of the Shawneetown Quadrangle, Gallatin County, Illinois: Illinois State Geological Survey Map IGQ-1.

Nelson, W. J., and D. K. Lumm, 1987, Structural Geology of Southeastern Illinois and Vicinity: Illinois State Geological Survey Circular 538, 70 p.

Orser, C. E., 1978, The Old State Bank at Shawneetown: Illinois Magazine, v. XVII, no. 3, March, pp. 37-41.

Poole, V. L., and E. W. Sanderson, 1981, Groundwater Resources in the Saline Valley Conservation District, Saline and Gallatin Counties, Illinois: Illinois State Geological Survey Contract/Grant Report: 1981-2, 37 p.

Samson, I. E., 1988, Illinois Mineral Industry in 1985 and Preliminary Mineral Production Data for 1986: Illinois State Geological Survey Illinois Mineral Note 99, 45 p.

Swann, D. H., 1964, Late Mississippian Rhythmic Sediments of Mississippi Valley: Bulletin of the American Association of Petroleum Geologists, vol. 48, no. 5, May, pp. 637-658.

Smith, W. H., 1958, Strippable Coal Reserves of Illinois: Part 2--Jackson, Monroe, Perry, and St. Clair Counties: Illinois State Geological Survey Circular 260, 35 p.

Treworgy, C. G., L. E. Bengal, and A. G. Dingwell, 1978, Reserves and Resources of Surface-Minable Coal in Illinois: Illinois State Geological Survey Circular 504, 44 p.

Treworgy, C. G., and M. H. Bargh, 1982, Deep-Minable Coal Resources of Illinois: Illinois State Geological Survey Circular 527, 65 p.

Treworgy, J. D., 1981, Structural Features in Illinois: A Compendium: Illinois State Geological Survey Circular 519, 22 p.

Treworgy, J. D., and M. H. Bargh, 1984, Coal Resources of Illinois: Springfield (No. 5) Coal: Illinois State Geological Survey Map; scale, 1:500,000; size, 30 by 50 inches; color.

Treworgy, J. D., and M. H. Bargh, 1984, Coal Resources of Illinois: Herrin (No. 6) Coal: Illinois State Geological Survey Map; scale 1:500,000; size, 30 by 50 inches; color.

Treworgy, J. D., and M. H. Bargh, 1984, Coal Resources of Illinois: Davis, Murphysboro, and Seelyville, with Assumption, Bell, Houchin Creek--formerly Summum (No. 4), Litchfield, coals near Makanda, Mt. Rorah, New Burside, Reynoldsburg, Rock Island (No. 1), "Seahorne," Servant--formerly Shawneetown, Wiley, Willis, and Wise Ridge Coals: Illinois State Geological Survey Map; scale 1:500,000; size, 30 by 50 inches, color.

Wayne, W. J., 1952, Pleistocene Evolution of the Ohio and Wabash Valleys: Jorunal of Geology, vol. 60, no. 6, November, pp 575-585.

Willman, H. B., et al., 1967, Geologic Map of Illinois: Illinois State Geological Survey Map; scale, 1:500,000; size, 40 by 56 inches; color.

Willman, H. B., et al., Handbook of Illinois Stratigraphy: Illinois State Geological Survey Bulletin 95, 261 p.

Willman, H. B., and J. C. Frye, 1980, The Glacial Boundary in Southern Illinois: Illinois State Geological Survey Circular 511, 23 pages.

Willman, H. B., J. A. Simon, B. M. Lynch, and V. A. Langenheim, 1968, Bibliography and Index of Illinois Geology through 1965: Illinois State Geolgical Survey Bulletin 92, 373 p.

MISSISSIPPIAN DEPOSITION

(The following quotation is from Report of Investigations 216: Classification of Genevievian and Chesterian...Rocks of Illinois [1965] by D. H. Swann, pp. 11-16. One figure and short sections of the text are omitted.)

During the Mississippian Period, the Illinois Basin was a slowly subsiding region with a vague north-south structural axis. It was flanked by structurally neutral regions to the east and west, corresponding to the present Cincinnati and Ozark Arches. These neighboring elements contributed insignificant amounts of sediment to the basin. Instead, the basin was filled by locally precipitated carbonate and by mud and sand eroded from highland areas far to the northeast in the eastern part of the Canadian Shield and perhaps the northeastward extension of the Appalachians. This sediment was brought to the Illinois region by a major river system, which it will be convenient to call the Michigan River (fig. 4) because it crossed the present state of Michigan from north to south or northeast to southwest....

The Michigan River delivered much sediment to the Illinois region during early Mississippian time. However, an advance of the sea midway in the Mississippian Period prevented sand and mud from reaching the area during deposition of the St. Louis Limestone. Genevievian time began with the lowering of sea level and the alternating deposition of shallow-water carbonate and clastic units in a pattern that persisted throughout the rest of the Mississippian. About a fourth of the fill of the basin during the late Mississippian was carbonate, another fourth was sand, and the remainder was mud carried down by the Michigan River.

Thickness, facies, and crossbedding...indicate the existence of a regional slope to the southwest, perpendicular to the prevailing north 65° west trend of the shorelines. The Illinois Basin, although developing structurally during this time, was not an embayment of the interior sea. Indeed, the mouth of the Michigan River generally extended out into the sea as a bird-foot delta, and the shoreline across the basin area may have been convex more often than concave.

....The shoreline was not static. Its position oscillated through a range of perhaps 600 to 1000 or more miles. At times it was so far south that land conditions existed throughout the present area of the Illinois Basin. At other times it was so far north that there is no suggestion of near-shore environment in the sediments still preserved. This migration of the shoreline and of the accompanying sedimentation belts determined the composition and position of Genevievian and Chesterian rock bodies.

Lateral shifts in the course of the Michigan River also influenced the placement of the rock bodies. At times the river brought its load of sediment to the eastern edge of the basin, at times to the center, and at times to the western edge. This lateral shifting occurred within a range of about 200 miles. The Cincinnati and Ozark areas did not themselves provide sediments, but, rather, the Michigan River tended to avoid those relatively positive areas in favor of the down-warped basin axis.

Sedimentation belts during this time were not symmetrical with respect to the mouth of the Michigan River. They were distorted by the position of the river relative to the Ozark and Cincinnati shoal areas, but of greater importance was sea current or drift to the northwest. This carried off most of the mud contributed by the river, narrowing the shale belt east of the river mouth and broadening it west

of the mouth. Facies and isopach maps of individual units show several times as much shale west of the locus of sand deposition as east of it. The facies maps of the entire Chesterian...show maximum sandstone deposition in a northeast-southwest belt that bisects the basin. The total thickness of limestone is greatest along the southern border of the basin and is relatively constant along that entire border. The proportion of limestone, however, is much higher at the eastern end than along the rest of the southern border, because little mud was carried southeastward against the prevailing sea current. Instead, the mud was carried to the northwest and the highest proportion of shale is found in the northwestern part of the basin.

Genevievian and Chesterian seas generally extended from the Illinois Basin eastward across the Cincinnati Shoal area and the Appalachian Basin. Little terrigeneous sediment reached the Cincinnati Shoal area from either the west or the east, and the section consists of thin limestone units representing all or most of the major cycles. The proportion of inorganically precipitated limestone is relatively high and the waters over the shoal area were commonly hypersaline... Erosion of the shoal area at times is indicated by the presence of conodonts eroded from the St. Louis Limestone and redeposited in the lower part of the Gasper Limestone at the southeast corner of the Illinois Basin...

The shoal area included regions somewhat east of the present Cincinnati axis and extended from Ohio, and probably southeastern Indiana, through central and east-central Kentucky and Tennessee into Alabama....

Toward the west, the seaway was commonly continuous between the Illinois Basin and central Iowa, although only the record of Genevievian and earliest Chesterian is still preserved. The seas generally extended from the Illinois and Black Warrior regions into the Arkansas Valley region, and the presence of Chesterian outliers high in the Ozarks indicates that at times the Ozark area was covered. Although the sea was continuous into the Ouachita region, detailed correlation of the Illinois sediments with the geosynclinal deposits of this area is difficult.

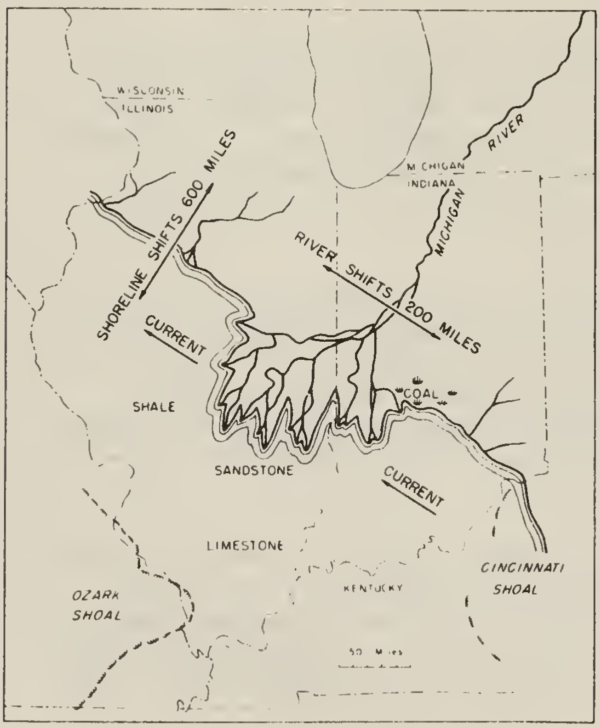


Figure 4: Paleogeography at an intermediate stage during Chesterian sedimentation.

DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS

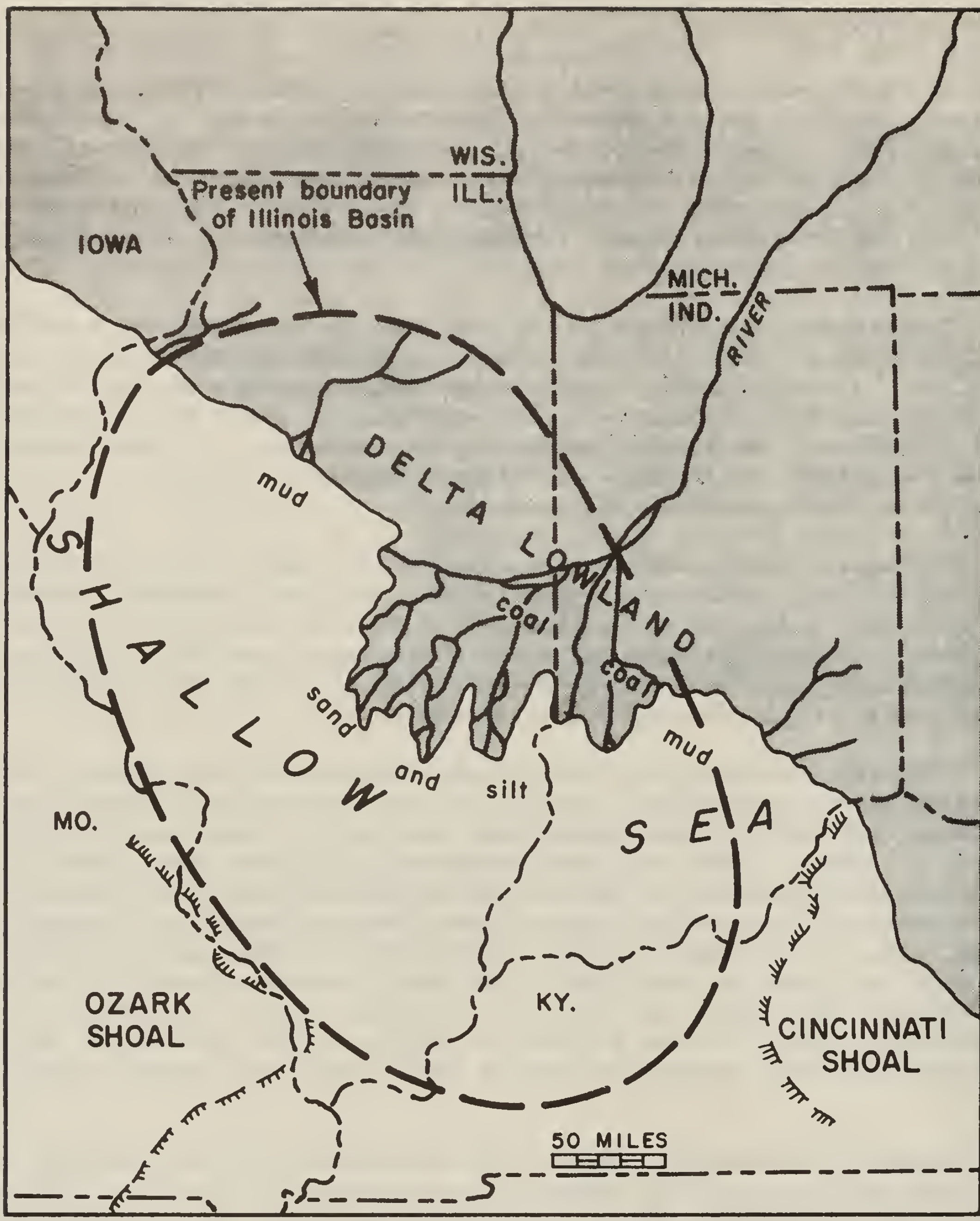
At the close of the Mississippian Period, about 310 million years ago, the Mississippian sea withdrew from the Midcontinent region. A long interval of erosion took place early in Pennsylvanian time and removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. An ancient river system cut deep channels into the bedrock surface. Erosion was interrupted by the invasion of the Morrowan (early Pennsylvanian) sea.

Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those that existed during Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands in the northeast. A great delta was built out into the shallow sea (see paleogeography map on next page). As the lowland stood only a few feet above sea level, only slight changes in relative sea level caused great shifts in the position of the shoreline.

Throughout Pennsylvanian time the Illinois Basin continued to subside while the delta front shifted owing to worldwide sea level changes, intermittent subsidence of the basin, and variations in the amounts of sediment carried seaward from the land. These alternations between marine and nonmarine conditions were more frequent than those during pre-Pennsylvanian time, and they produced striking lithologic variations in the Pennsylvanian rocks.

Conditions at various places on the shallow sea floor favored the deposition of sandstone, limestone, or shale. Sandstone was deposited near the mouths of distributary channels. These sands were reworked by waves and spread as thin sheets near the shore. The shales were deposited in quiet-water areas—in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Most sediments now recognized as limestones, which are formed from the accumulation of limey parts of plants and animals, were laid down in areas where only minor amounts of sand and mud were being deposited. Therefore, the areas of sandstone, shale, and limestone deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sandstones, shales, and limestones were deposited on the deltaic lowland bordering the sea. The nonmarine sandstones were deposited in distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies, 100 or more feet thick, were deposited in channels that cut through many of the underlying rock units. The shales were deposited mainly on floodplains. Freshwater limestones and some shales were deposited locally in fresh-water lakes and swamps. The coals were formed by the accumulation of plant material, usually where it grew, beneath the quiet waters of extensive swamps that prevailed for long intervals on the emergent delta lowland. Lush forest vegetation, which thrived in the warm, moist Pennsylvanian climate, covered the region. The origin of the underclays beneath the coals is not precisely known, but they were probably deposited in the swamps as slackwater muds before the formation of the coals. Many underclays contain plant roots and rootlets that appear to be in their original places. The formation of coal marked the end of the nonmarine portion of the depositional cycle, for resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were then laid down over the coal.



Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows the Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

Pennsylvanian Cyclothems

Because of the extremely varied environmental conditions under which they formed, the Pennsylvanian strata exhibit extraordinary variations in thickness and composition, both laterally and vertically. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and

limestones, however, display remarkable lateral continuity for such thin units (usually only a few feet thick). Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting front of the delta lowland. Each series of alternations, called a cyclothem, consists of several marine and nonmarine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an ideally complete cyclothem consists of 10 sedimentary units. The chart on the next page shows the arrangement. Approximately 50 cyclothems have been described in the Illinois Basin, but only a few contain all 10 units. Usually one or more are missing because conditions of deposition were more varied than indicated by the ideal cyclothem. However, the order of units in each cyclothem is almost always the same. A typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheety shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal portion (the lower 5 units) of each cyclothem is nonmarine and was deposited on the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal are marine sediments and were deposited when the sea advanced over the delta lowland.

Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh-to-brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothems. The swamps occupied vast areas of the deltaic coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm Pennsylvanian climate. Today's common deciduous trees were not present, and the flowering plants had not yet evolved. Instead, the jungle-like forests were dominated by giant ancestors of present-day club mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate. Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

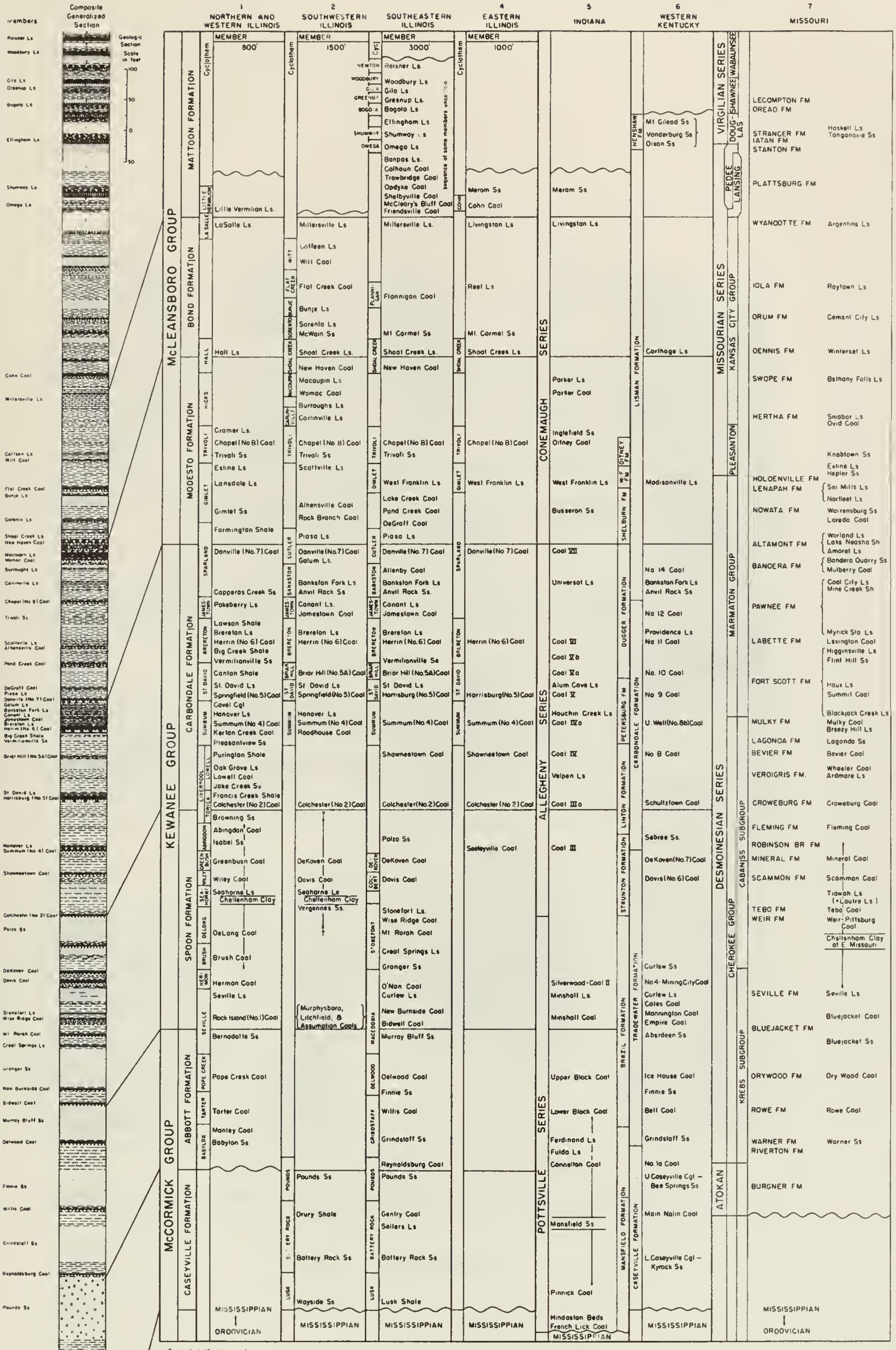
Plant debris from the rapidly growing swamp forests—leaves, twigs, branches, and logs—accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably stagnant and low in oxygen, prevented the complete oxidation and decay of the peat deposits.

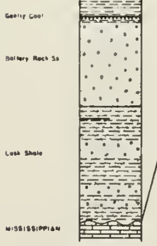
The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests and initiated marine conditions of deposition. The peat deposits were buried by marine sediments. Following burial, the peat deposits were gradually transformed into coal by slow chemical and physical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coalification process, and the peat deposits were changed into coal.

Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

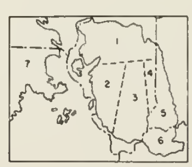
The exact origin of the carbonaceous black shales that occur above many coals is uncertain. The black shales probably are deposits formed under restricted marine (lagoonal) conditions during the initial part of the invasion cycle, when the region was partially closed off from the open sea. In any case, they were deposited in.quiet-water areas where very fine, iron-rich muds and finely divided plant debris were washed in from the land. The high organic content of the black shales is also in part due to the carbonaceous remains of plants and animals that lived in the lagoons. Most of the fossils represent planktonic (floating) and nektonic (swimming) forms—not benthonic (bottom dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shales formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient waters of the lagoons. However, study has shown that the "depauperate" fauna consists mostly of normal-size individuals of species that never grew any larger.





ROCK STRATIGRAPHIC
AND
CYCLICAL CLASSIFICATIONS
OF THE
PENNSYLVANIAN STRATA OF ILLINOIS

1960



LOCATION MAP

10 Shale, gray, sandy at top; contains marine fossils and ironstone concretions especially in lower part.

9 Limestone; contains marine fossils.

8 Shale, black, hard, laminated; contains large spheroidal concretions ("Niggerheads") and marine fossils.

7 Limestone; contains marine fossils.

6 Shale, gray; pyritic nodules and ironstone concretions common at base; plant fossils locally common at base; marine fossils rare.

5 Coal; locally contains clay or shale partings.

4 Underclay, mostly medium to light gray except dark gray at top; upper part noncalcareous, lower part calcareous.

3 Limestone, argillaceous; occurs in nodules or discontinuous beds; usually nonfossiliferous.

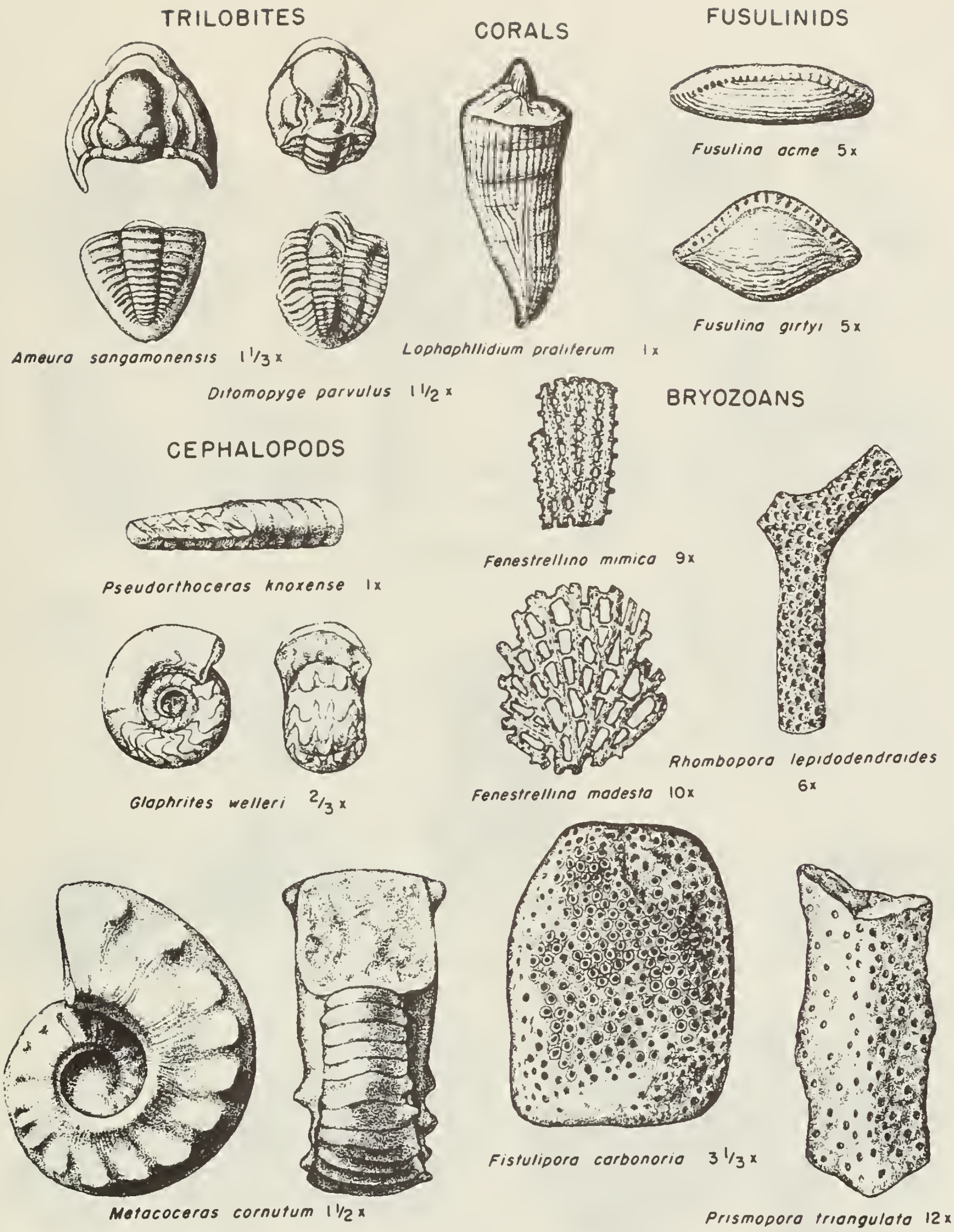
2 Shale, gray, sandy.

1 Sandstone, fine-grained, micaceous, and siltstone, argillaceous; variable from massive to thin-bedded; usually with an uneven lower surface.

AN IDEALLY COMPLETE CYCLOTHEM

(Reprinted from Fig. 42, Bulletin No. 66, Geology and Mineral Resources of the Marseilles, Ottawa, and Streator Quadrangles, by H. B. Willman and J. Norman Payne)

(47669—15M—11-61)



TRILOBITES
CORALS
FUSULINIDS
Fusulina acme 5x
Fusulina girtyi 5x
Ameura sangamonensis 1 1/3 x
Lophophllidium proliferum 1x
Ditomopyge parvulus 1 1/2 x
BRYOZOANS
CEPHALOPODS
Pseudorthoceras knoxense 1x
Fenestrellina mimica 9x
Glaphrites welleri 2/3 x
Fenestrellina modesta 10x
Rhombopora lepidodendroides 6x
Fistulipora carbonaria 3 1/3 x
Metacoceras cornutum 1 1/2 x
Prismopora triangulata 12x

PELECYPODS

Nucula (Nuculopsis) girtyi 1x

Edmonia ovata 2x

Astartella concentrica 1x

Dunbarella knighti 1 1/2 x

Cardiomorpha missouriensis
"Type A" 1x

Cardiomorpha missouriensis
"Type B" 1 1/2 x

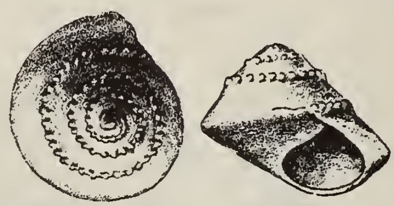
GASTROPODS

Euphemites carbonarius 1 1/2 x

Donaldina robusta 8x

Trepospira illinoisensis 1 1/2 x

Naticopsis (Jedria) ventricosa 1 1/2 x

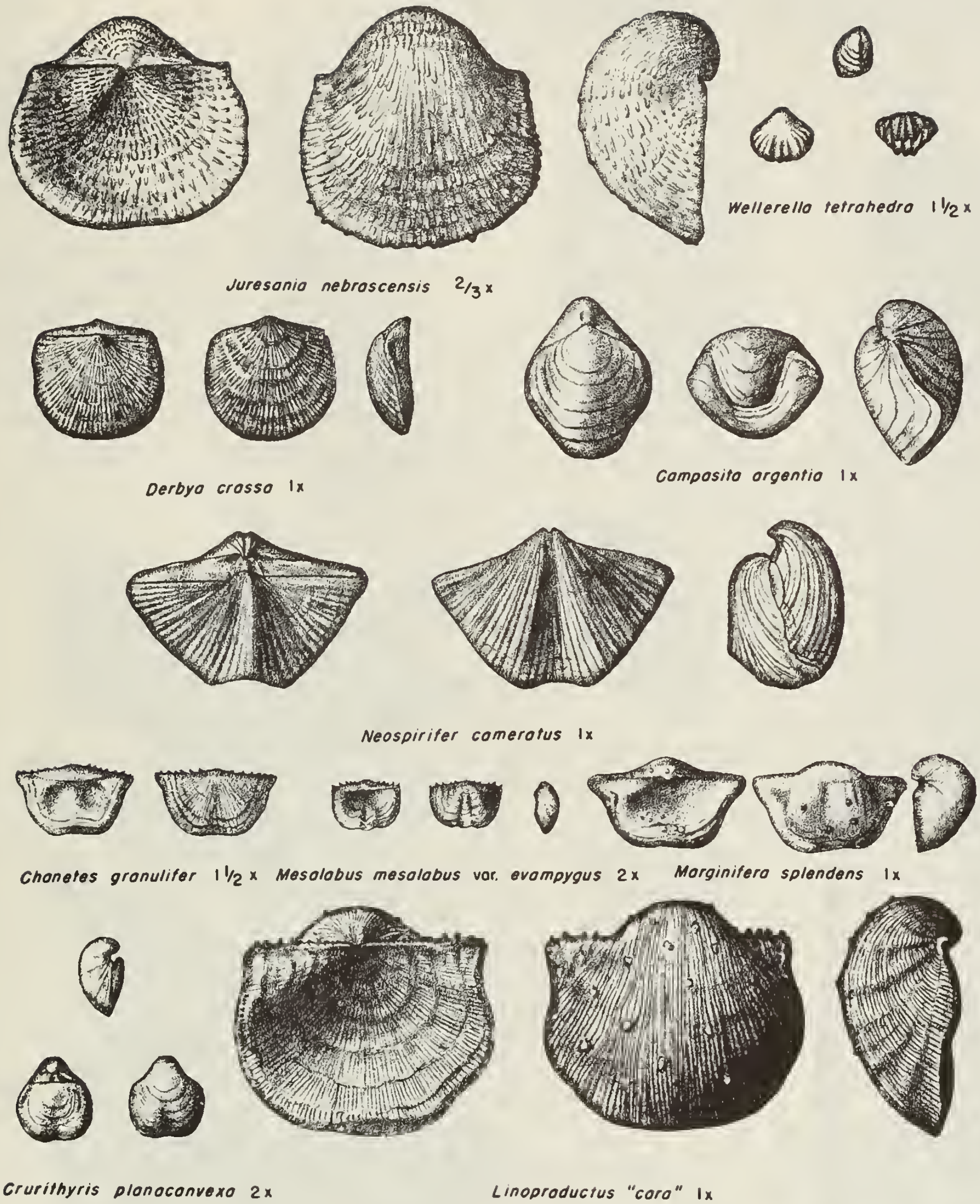


Trepospira sphaerulata 1x

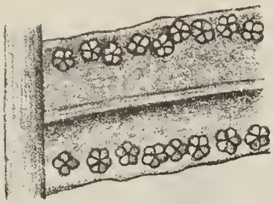
Knightites montfortianus 2x

Glabrocingulum (Glabrocingulum) grayvillense 3x

BRACHIOPODS

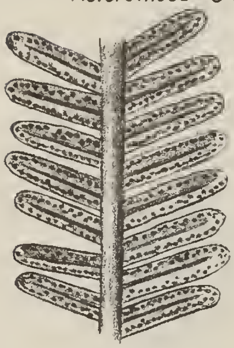


FOSSIL PLANTS, FRANCIS CREEK SHALE

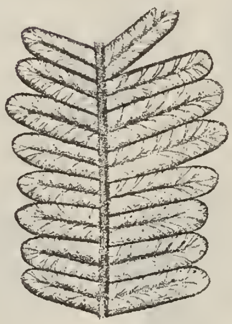


Asterotheca 5:1

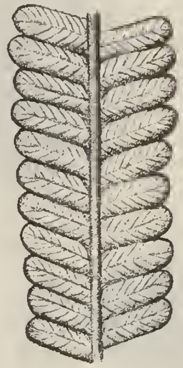
Pecopteris 5:1



Asterotheca sp. 1:1



Pecopteris sp. 1:1

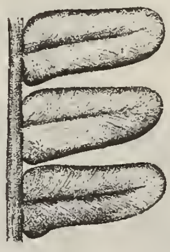


Pecopteris unita 1:1

Pecopteris sp. 1:1

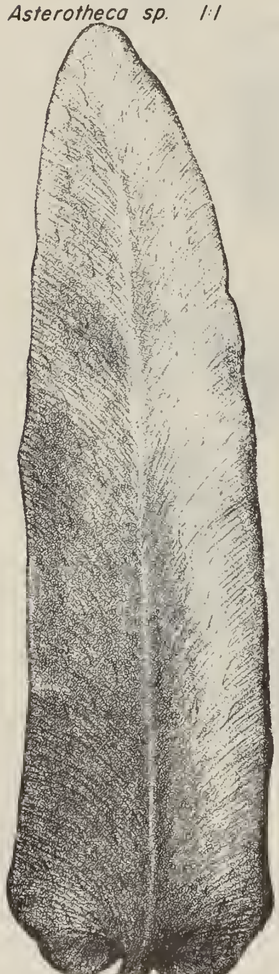
Sphenopteris sp. 1:1

Neuropteris rarinervis 1:1

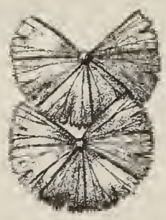


Neuropteris ovata 1:1

Sphenopteris sp. 1:1



Neuropteris scheuchzeri 1:1

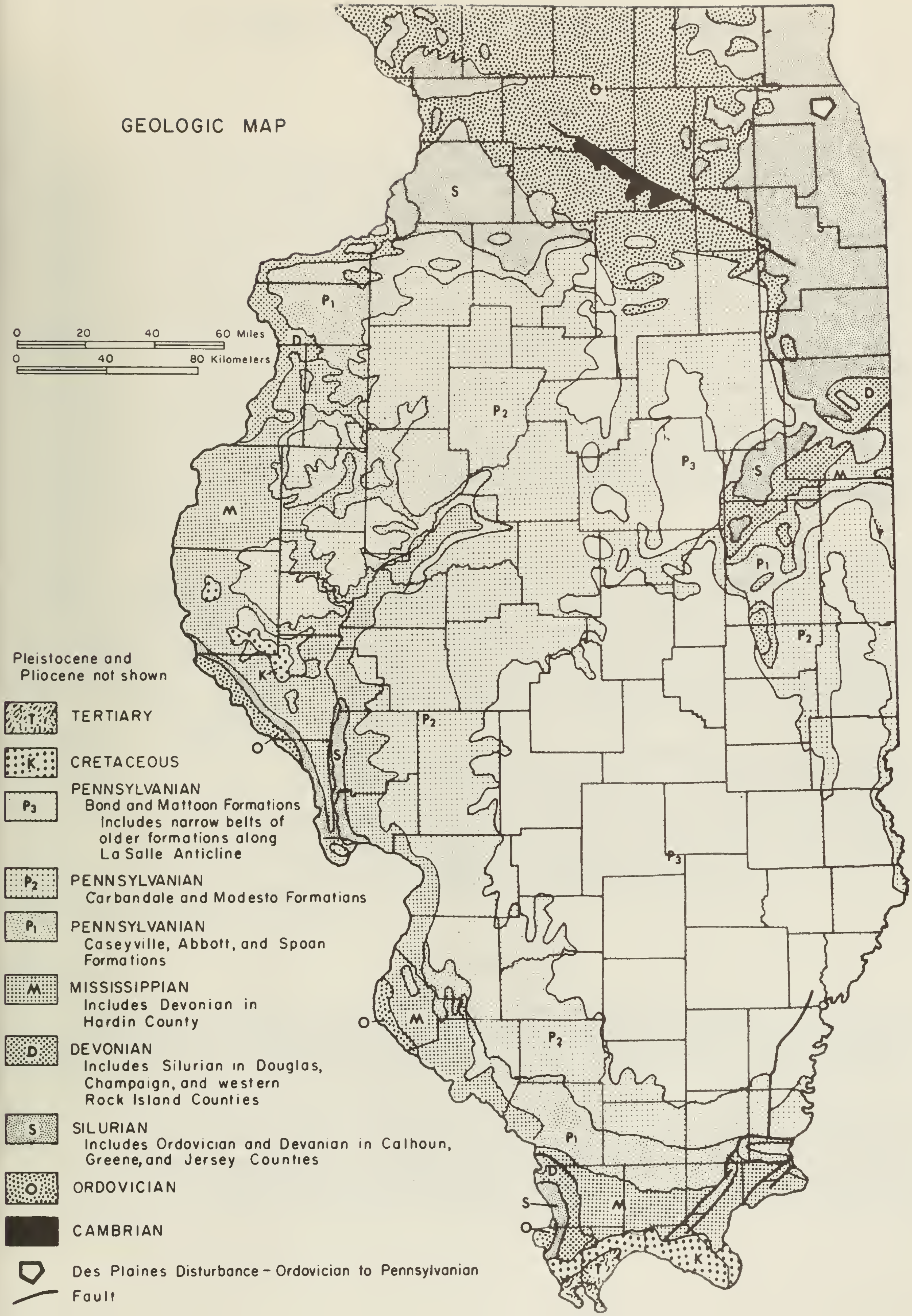


Sphenophyllum sp. 1:1

Alethopteris serlii 1:1

Mariopteris sp. 1:1

PLATE 3
(corrected)


GEOLOGIC MAP
0 20 40 60 Miles
0 40 80 Kilometers
Pleistocene and
Pliocene not shown
TERTIARY
CRETACEOUS
PENNSYLVANIAN
Bond and Mattoon Formations
Includes narrow belts of
older formations along
La Salle Anticline
PENNSYLVANIAN
Carbandale and Modesto Formatians
PENNSYLVANIAN
Caseyville, Abbott, and Spoan
Formations
MISSISSIPPIAN
Includes Devonian in
Hardin County
DEVONIAN
Includes Silurian in Douglas,
Champaign, and western
Rock Island Counties
SILURIAN
Includes Ordovician and Devanian in Calhoun,
Greene, and Jersey Counties
ORDOVICIAN
CAMBRIAN
Des Plaines Disturbance – Ordovician to Pennsylvanian
Fault

PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, an interval of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. The cooling of the earth's surface, a prerequisite for glaciation, began at least 2 million years ago. On the basis of evidence found in subpolar oceans of the world (temperature-dependent fossils and oxygen-isotope ratios), a recent proposal has been made to recognize the beginning of the Pleistocene at 1.6 million years ago. Ice sheets formed in sub-arctic regions many times and spread outward until they covered the northern parts of Europe and North America. In North America, early studies of the glacial deposits led to the model that four glaciations could explain the observed distribution of glacial deposits. The deposits of a glaciation were separated from each other by the evidence of intervals of time during which soils formed on the land surface. In order of occurrence from the oldest to the youngest, they were given the names Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. Work in the last 30 years has shown that there were more than four glaciations but the actual number and correlations at this time are not known. Estimates that are gaining credibility suggest that there may have been about 14 glaciations in the last one million years. In Illinois, estimates range from 4 to 8 based on buried soils and glacial deposits. For practical purposes, the previous four glacial stage model is functional, but we now know that the older stages are complex and probably contain more than one glaciation. Until we know more, all of the older glacial deposits, including the Nebraskan and Kansan will be classified as pre-Illinoian. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.

The North American ice sheets developed when the mean annual temperature was perhaps 4° to 7°C (7° to 13°F) cooler than it is now and winter snows did not completely melt during the summers. Because the time of cooler conditions lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was enough to lower the sea level from 300 to 400 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the buried deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called **drift**. Drift that is ice-laid is called **till**. Water-laid drift is called **outwash**.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also stratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders. For descriptive purposes, a mixture of clay, silt, sand and boulders is called **diamicton**. This is a term used to describe a deposit that could be interpreted as till or a mass wasting product.

Tills may be deposited as **end moraines**, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as **ground moraines**, or **till plains**, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called **outwash**. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size—the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits in some places. In general, outwash tends to be coarser and less weathered, and alluvium is most often finer than medium sand and contains variable amounts of weathered material.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an **esker**. Some eskers in Illinois are made up of sandy to silty deposits and contain mass wasted diamicton material. Cone-shaped mounds of coarse outwash, called **kames**, were formed where meltwater plunged through crevasses in the ice or into ponds on the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake rapidly lost speed and also quickly dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were commonly redistributed on the lake bottom by wind-generated currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an **outwash plain**. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as **valley trains**. Valley train deposits may be both extensive and thick. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess, Eolian Sand and Soils

One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. **Loess** is the name given to windblown deposits dominated by silt. Most of the silt was derived from wind erosion of the valley trains. Wind action also sorted out **eolian sand** which commonly formed **sand dunes** on the valley trains or on the adjacent uplands. In places, sand dunes have migrated up to 10 miles away from the principle source of sand. Flat areas between dunes are generally underlain by eolian **sheet sand** that is commonly reworked by water action. On uplands along the major valley trains, loess and eolian sand are commonly interbedded. With increasing distance from the valleys, the eolian sand pinches out, often within one mile.

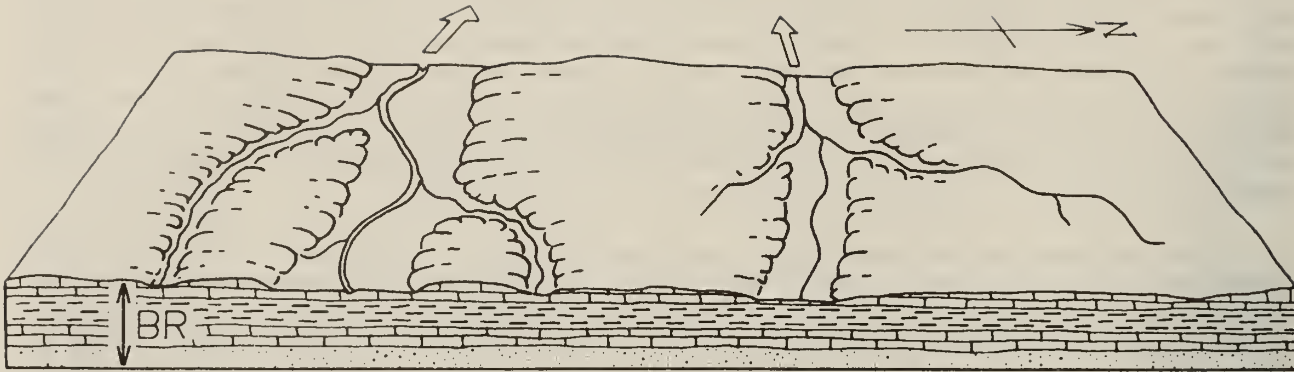
Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but some were buried. Those that survive serve as "key beds," or stratigraphic markers, and are evidence of the passage of a long interval of time.

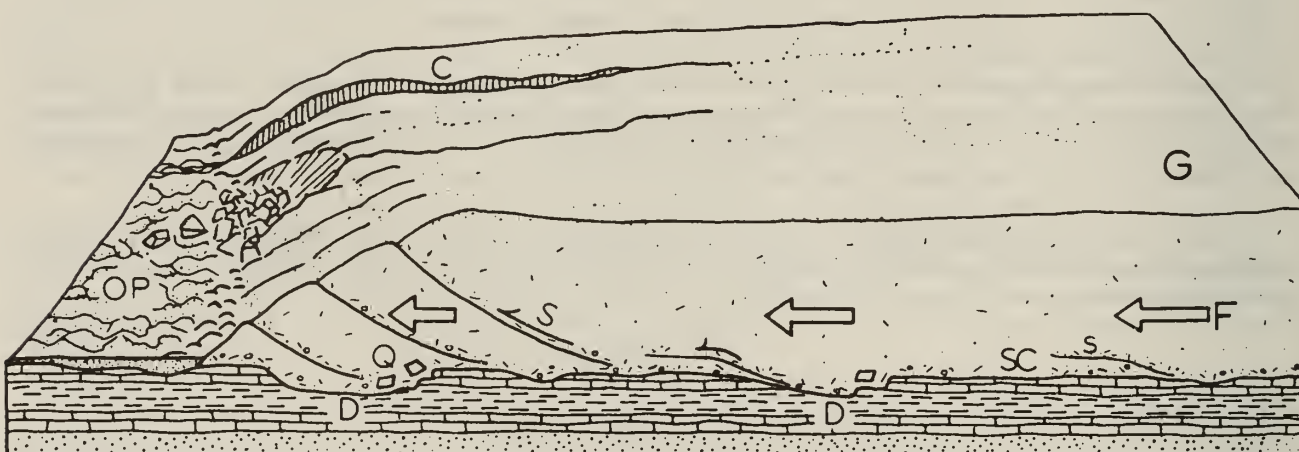
Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked at various stages as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

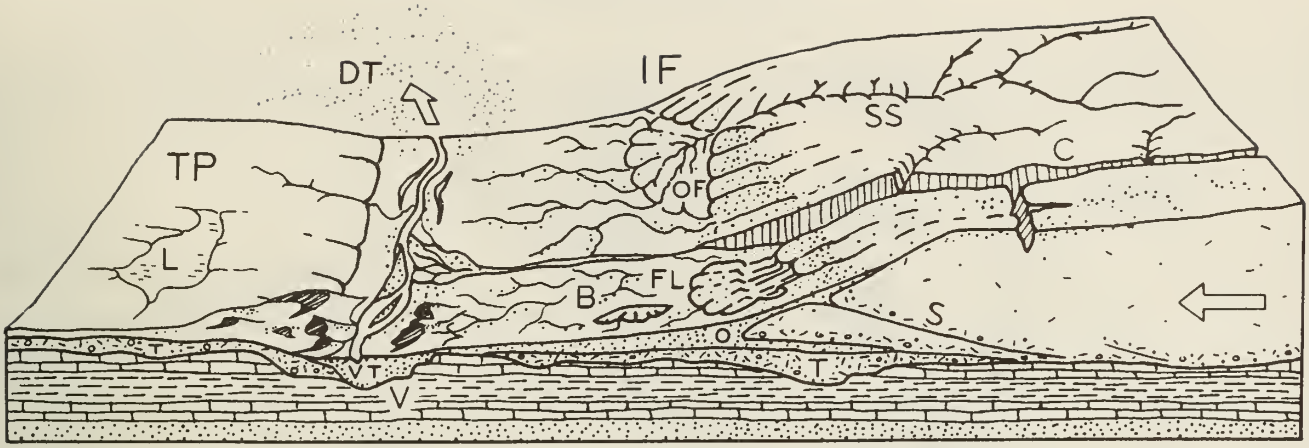
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



1. **The Region Before Glaciation** — Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks—layers of sandstone ( ), limestone ( ), and shale ( ). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



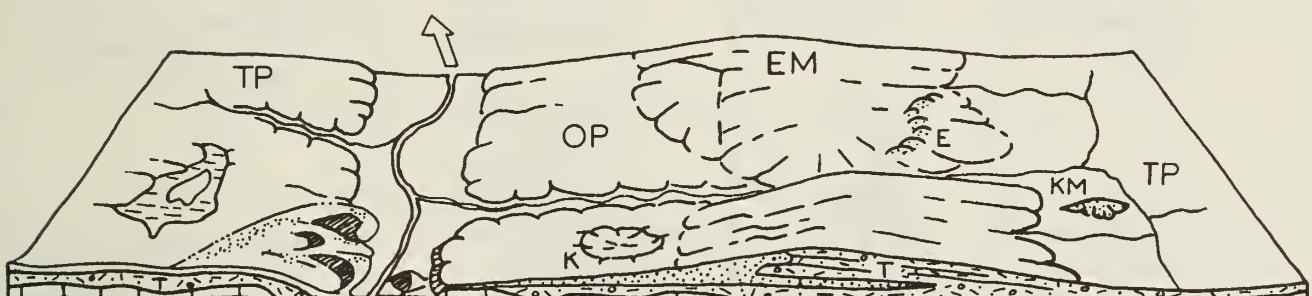
2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick, and tapers to the margin, which was probably in the range of several hundred feet above the old terrain. The ice front advances perhaps as much as a third of a mile per year.



3. **The Glacier Deposits an End Moraine** — After the glacier advances across the area, the climate warms and the ice begins to melt as fast as it advances. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that is mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A supraglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) remains as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remains a low spot in the terrain. As soon as the ice cover melts, meltwater drains down the valley, cutting it deeper. Later, outwash partly refills the valley: the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles. Sand dunes (D) form on the south and east sides of streams.



4. **The Region after Glaciation** — As the climate warms further, the whole ice sheet melts, and glaciation ends. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

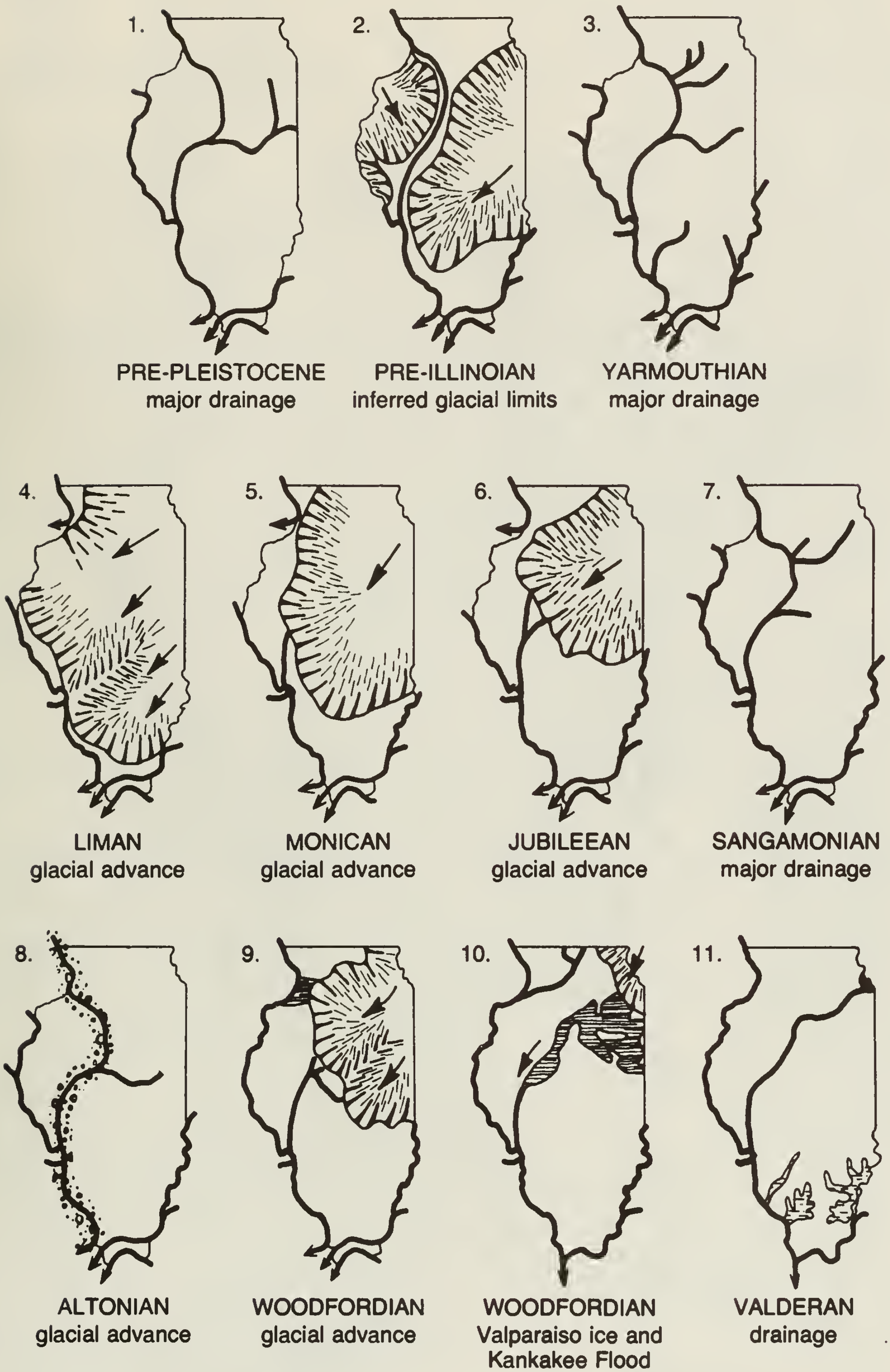
TIME TABLE OF PLEISTOCENE GLACIATION

		STAGE		SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
QUATERNARY		HOLOCENE (interglacial)		Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
				10,000		
	Pleistocene	WISCONSINAN (glacial)		Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
				11,000		
				Twocreekan	Peat and alluvium	Ice withdrawal, erosion
				12,500		
			late	Woodfordian	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
				25,000		
			mid	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion
				28,000		
			early	Altonian	Drift, loess	Glaciation in Great Lakes area, valley trains along major rivers
				75,000		
		SANGAMONIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
				125,000		
		ILLINOIAN (glacial)		Jubileean	Drift, loess, outwash	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
				Monican	Drift, loess, outwash	
				Liman	Drift, loess, outwash	
				300,000?		
		YARMOUTHIAN (interglacial)			Soil, mature profile of weathering	Important stratigraphic marker
				500,000?		
	Pre-Illinoian	KANSAN* (glacial)			Drift, loess	Glaciers from northeast and northwest covered much of state
				700,000?		
		AFTONIAN* (interglacial)			Soil, mature profile of weathering	(hypothetical)
				900,000?		
		NEBRASKAN* (glacial)			Drift (little known)	Glaciers from northwest invaded western Illinois
				1,600,000 or more		

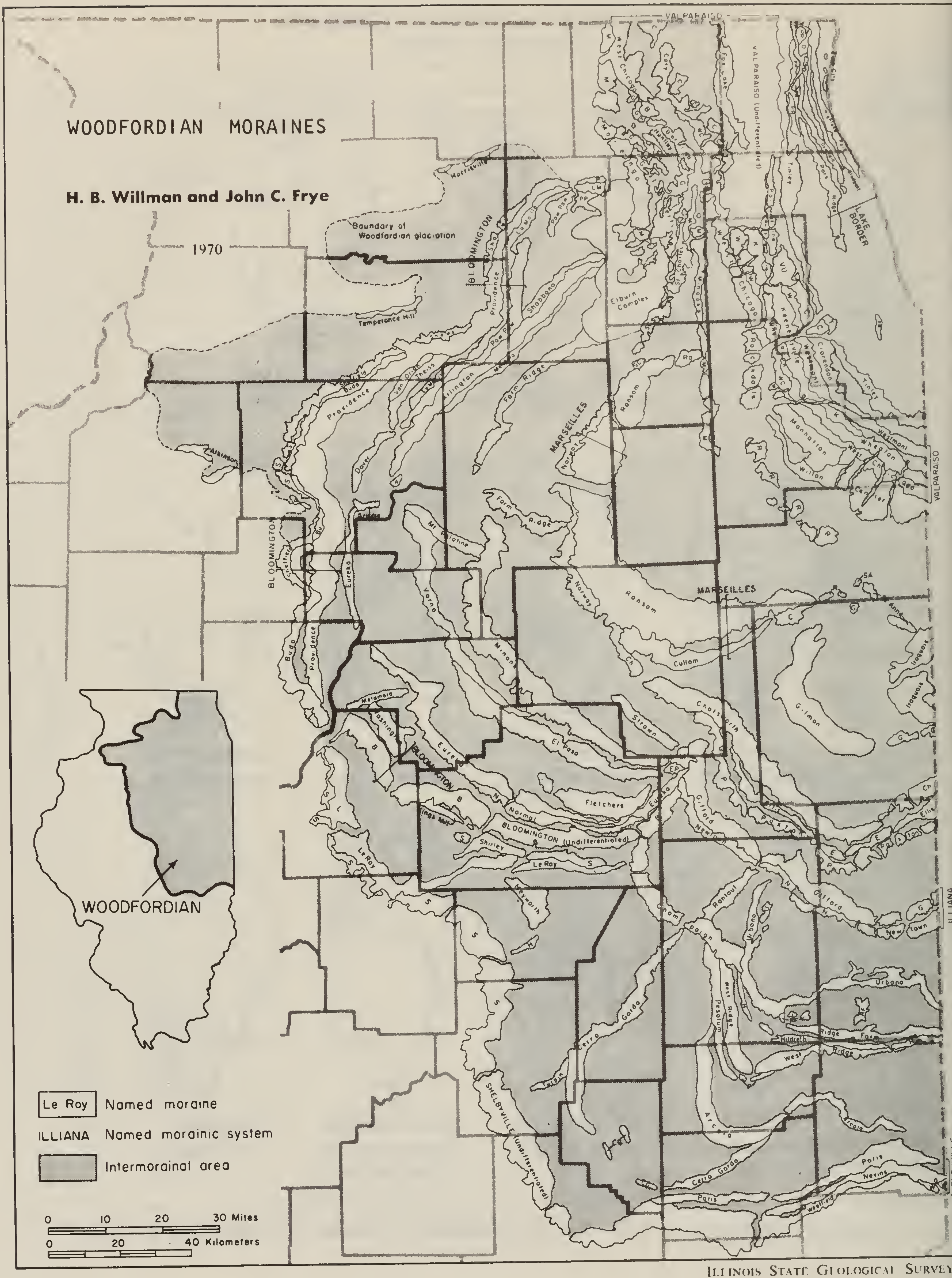
*Old oversimplified concepts, now known to represent a series of glacial cycles.

(Illinois State Geological Survey, 197

SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS



(Modified from Willlman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)


WOODFORDIAN MORAINES
H. B. Willman and John C. Frye
1970
Boundary of Woodfordian glaciation
WOODFORDIAN
Le Roy Named moraine
ILLIANA Named morainic system
Intermorainal area
0 10 20 30 Miles
0 20 40 Kilometers
VALPARAISO
VALPARAISO (Undifferentiated)
LAKE BORDER
BLOOMINGTON
BLOOMINGTON (Undifferentiated)
MARSEILLES
ILLIANA
SHELBYVILLE
SHELBYVILLE (Undifferentiated)
Morrisville
Temperance Hill
Atkinson
Providence
Shabbona
Paw Paw
Arlington
Mendota
Farm Ridge
Dover
Van Orin
Theiss
Buda
Sheffield
Eureka
Mt. Palatine
Varna
Minonk
Metamora
Washington
Normal
Fletchers
El Paso
Shirley
Le Roy
Kings Mill
Heyworth
Ransom
Norway
Cullom
Chatsworth
Strawn
Gilman
Iroquois
Gifford
Newtown
Paxton
Ellis
Rantoul
Urbana
Pesotum
West Ridge
Farm Ridge
Cerro Gordo
Arcola
Paris
Nevins
Westfield
Elburn Complex
West Chicago
Minooka
Rockdale
Manhattan
Wilton
Wheaton
Westmont
Clarendon
Keeneyville
Tinley
Park Ridge
Fox Lake
Cary
Chicago
Hudrick

ILLINOIS STATE GEOLOGICAL SURVEY

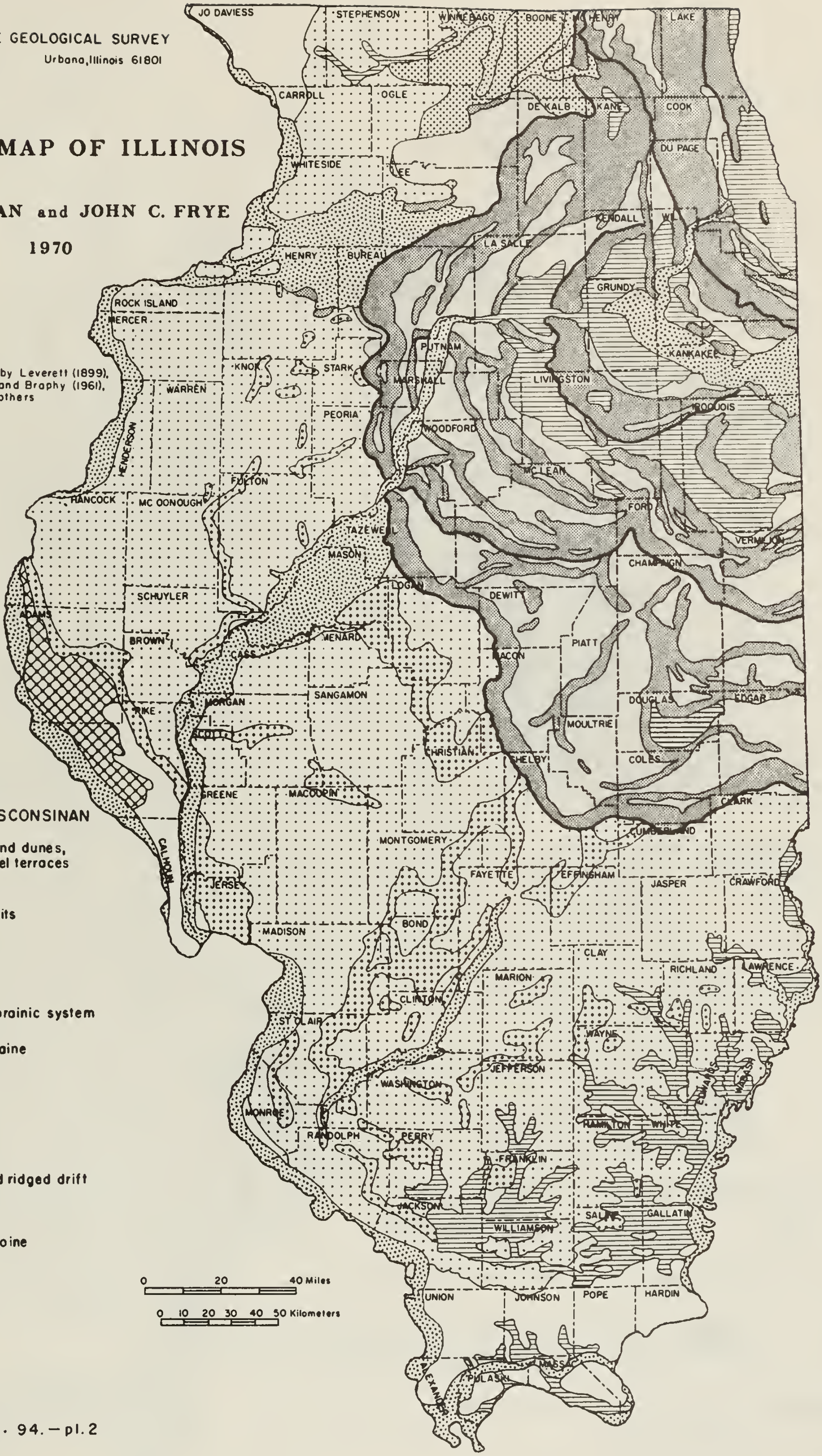
John C. Frye, Chief   Urbana, Illinois 61801

GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

Modified from maps by Leverett (1899), Ekblow (1959), Leighton and Brophy (1961), Willman et al. (1967), and others



EXPLANATION

HOLOCENE AND WISCONSINAN

Alluvium, sand dunes, and gravel terraces

WISCONSINAN

Lake deposits

WOODFORDIAN

Moraine

Front of morainic system

Groundmoraine

ALTONIAN

Till plain

ILLINOIAN

Moraine and ridged drift

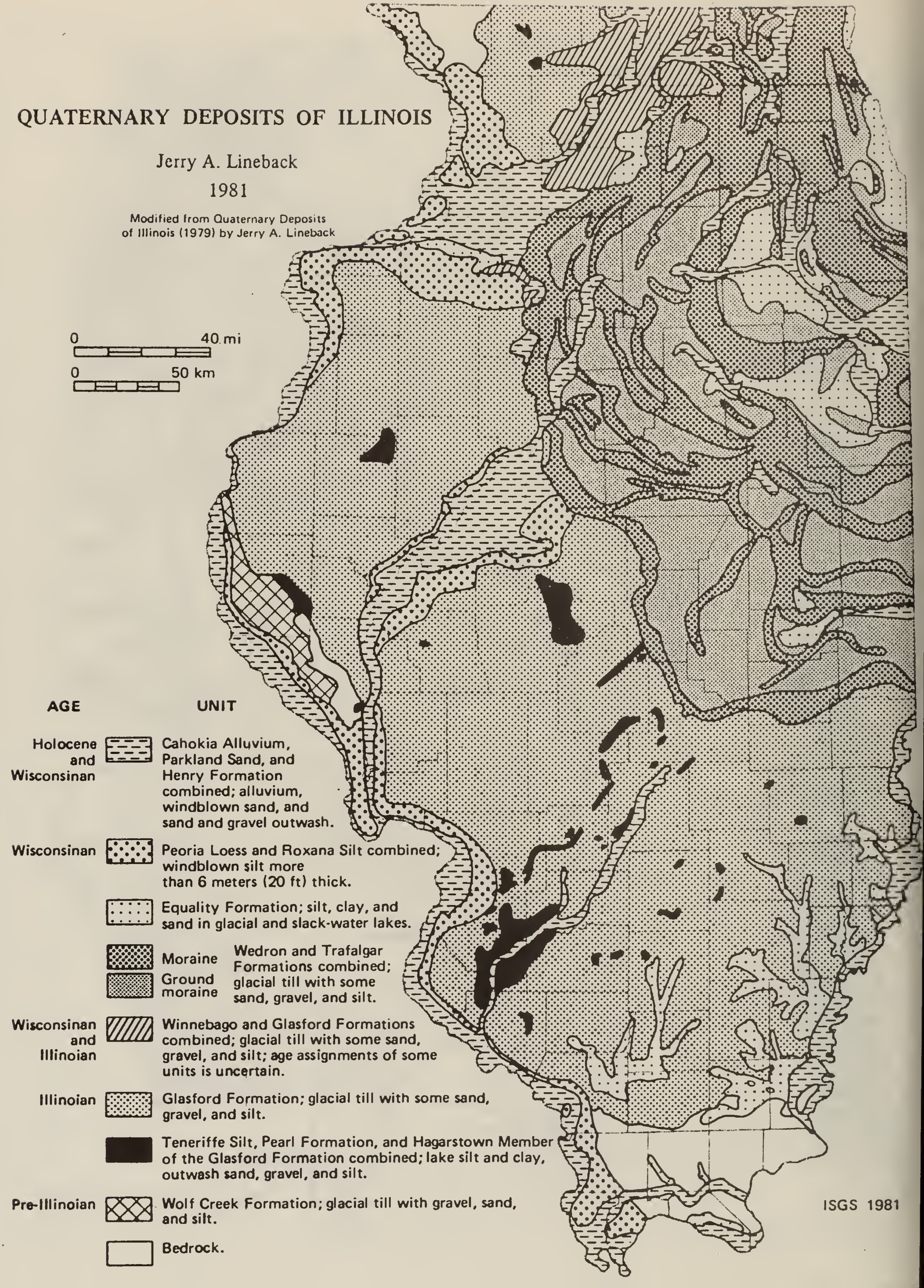
Groundmoraine

KANSAN

Till plain

DRIFTLESS

Modified from Bull. 94.—pl. 2


QUATERNARY DEPOSITS OF ILLINOIS
Jerry A. Lineback
1981
Modified from Quaternary Deposits of Illinois (1979) by Jerry A. Lineback
0 40 mi
0 50 km
AGE
UNIT
Holocene and Wisconsinan
Cahokia Alluvium, Parkland Sand, and Henry Formation combined; alluvium, windblown sand, and sand and gravel outwash.
Wisconsinan
Peoria Loess and Roxana Silt combined; windblown silt more than 6 meters (20 ft) thick.
Equality Formation; silt, clay, and sand in glacial and slack-water lakes.
Moraine
Ground moraine
Wedron and Trafalgar Formations combined; glacial till with some sand, gravel, and silt.
Wisconsinan and Illinoian
Winnebago and Glasford Formations combined; glacial till with some sand, gravel, and silt; age assignments of some units is uncertain.
Illinoian
Glasford Formation; glacial till with some sand, gravel, and silt.
Teneriffe Silt, Pearl Formation, and Hagarstown Member of the Glasford Formation combined; lake silt and clay, outwash sand, gravel, and silt.
Pre-Illinoian
Wolf Creek Formation; glacial till with gravel, sand, and silt.
Bedrock.
ISGS 1981


START
LUNCH
END
1
2
3
4
5
6
7
8
9
10
11
SHAWNEETOWN
POP 1742
JUNCTION
POP 199
OLD SHAWNEETOWN
TOLL BRIDGE
BOWLESVILLE
GIBSONIA
FOREST
G O L D
H I L L
S H A
B O W L E S V I L L E
NATIONAL
CYPRESS
DITCH
OHIO
LONG POND
SALINE
FAP 14
L&N
B & O
TO MORG
SCALE
0 1 2 3 4 5 MILES
0 5000 10000 15000 20000 25000 FEET